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The American Midland Naturalist

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EARLIEST SPRING-FLOWERING PLANTS

Over-country Midland to Galveston, Texas — Green Bay, Wisconsin

HERMANN C. BENKE

Having made several trips across the country from Wisconsin to Texas—"from the Lakes to the Gulf," and made collections of the earliest flowering plants with notes concerning them and aided also by herbarium records, the author is able to submit herewith a table of the Earliest Spring Flora (excluding most of the trees and shrubs) over a zone extending from Green Bay, Wisconsin on the north in a direction about NNE. to SSW. to Galveston, Texas at the southern limit, which distance is divided into ten convenient areas by as many observation stations, listing the earliest spring flora centering for some distance about these places.

The regions about the stations have been visited in earliest vernal anthesis—some of them repeatedly—and explored for distances about, thus making an almost continuous zone of observation across the country.

The flora is roughly given in four degrees of relative frequency as observation would warrant, viz: common, fairly common, uncommon and rare, these being relative terms. To illustrate, "common" as applied to *Taraxacum officinale* includes vastly more individual plants than the same term when applied to *Erythronium americanum*.

There being no exact order of procession of the flowering plants a fair average was sought. For example: while residing at Manitowoc, Wis. in the Green Bay territory—and later at Elgin, for a number of years at each place, every first ap-

pearance of spring flowers was anticipated with the keenest interest and closely watched. Not considering the first blossoms up in the trees and leaving out the almost year-round blooms of *Cerastium vulgatum*, *Stellaria media* and *Spathyema foetida* almost invariably first where it occurs—a variety of species were noted as the *very first* ones in flower in different years, among them: *Erythronium americanum*, *Hepatica americana* (or *H. acutiloba*), *Dentaria diphylla*, *Sanguinaria canadensis*, species of *Viola*, and even the Compositae—*Petasites palmatus* and *Antennaria plantaginifolia*. Hence, we here list as the "Earliest Spring Flora" such species as, on the average appear almost together—say within a week—and on average or comparative dates as given in the table. In the southern part of the territory, Galveston, Houston, and about Dallas in sheltered situations, some wild flowers are to be found in bloom the year around. It has been observed, however, that even so far south as Galveston Island there is a short dormant period with little flowering life even in the shelters of cultivation, so that the first real "burst of spring" comes there not until the first days of March—the 5th day of that month strikes a fair average, it was found, and is so given in the table. Because of the almost year-round procession of the flowers here, the order of their appearance varies much more than in latitudes farther north. Many a plant of the region might make its appearance in early spring, including some species usually grouped with the late summer or fall flowers as the table shows, among them, *Helianthus petiolaris*, *Solanum nigrum* and *Sonchus oleraceus*.

That a species is absent from localities in the table does not necessarily imply that it does not occur in the region. As an example, *Tradescantia reflexa* occurs about most of the stations listed, but as an early spring species it was observed only at Galveston and Houston.

HARDY, WIDE-SPREAD SPECIES; UNIVERSAL FLOWERING PLANTS

A few species—some classed as mere weeds—occur as earliest spring flora over the entire zone across the country and beyond; among these, *Stellaria media*, *Cerastium vul-*

gatum, Claytonia virginica, Capsella Bursa-pastoris, Fragaria virginiana, Prunus americana, Oxalis spp., several species of *Viola, Comandra* sp., *zizia aurea, Antennaria plantaginifolia* and *Taraxacum officinale.*

Noteworthy of mention here are two species of plants which are almost universal both as to place of habitation and flowering-time—*Stellaria media* and *Cerastium vulgatum.* In sheltered nooks they have been observed in flower even amid winter storms of our northern-most range. *Capsella Bursa-pastoris* and *Taraxacum officinale* will almost qualify in this singular class, too. So we may well vest the two former species with the title of c o s m o p o l i t a n f l o w e r s — so wonderfully hardy as to be almost universal both as to time of flowering and distribution, though their liberality of spending may be little appreciated and they are casually classed as "weeds."

DATES AVERAGED AND RELATIVE

Dates as given in the table are comparative for the different stations. Weather conditions vary with different years and relatively so with respect to the various places. An unseasonable frost, a period of wind or cloudiness can work quite a change not only in the dates of first flowering, but in their respective orders of appearance. For example: it has happened that a bouquet of anemone, dentaria, hepatica, etc. was gathered about Green Bay when the season was still backward much farther south about Milwaukee and these flowers could not be had there till some days later.

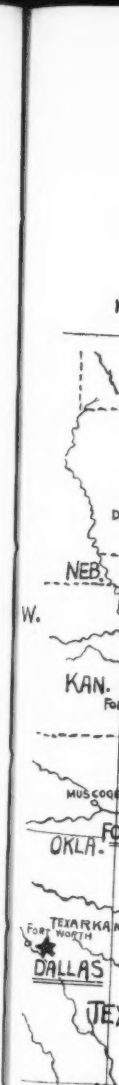
The earliest flowers of the Ozarks are found in sheltered ravines and on the southern expose of cliffs, bluffs, or hill slopes, so they are limited to these situations in the table. The flora of the north side of a high hill or mountain is quite different as to flowering-time (and as to species represented) from that on the southern slope. At the dates given in the table for the Ozarks region flora about Springfield, Mo. and Fort Smith, Ark. the north sides of hills and bluffs were quite bare of flowers, with the exception of an occasional colony of *Erythronium albidum* and the ever present *Stellaria Cerastium.*

SPACING APART OF OBSERVATION STATIONS; ALTITUDES AND SOILS

The spacing apart of the observation stations is not equidistant either as to periods of space or flowering time, but approximately so. Houston and Galveston are but 50 miles distant from each other, yet the differences in climatic conditions affecting vegetation are about as great as those between Houston and Dallas, though these latter stations are over 200 miles apart—a distance four times as great. The altitudes have not the violent range of difference of mountain variations. They run up from almost sea level on Galveston Island and lake level (about 580 feet) of Lake Michigan near Green Bay to some 1,500 feet about Springfield, Mo. Our zone runs across the Wisconsin woodlands, over the prairies of Illinois to the Mississippi River (about 415 feet) crossing the river about St. Louis (430 feet), thence through the Ozark uplift up to 1,300 and 1,500 feet about Springfield, Mo., Fort Smith, Ark. (450 feet) and beyond through the prairies and plains of Texas over Dallas (430 feet), to the gulf by way of Houston (only 50 feet over sea level) in the edge of the coastal plain. Hence the range runs along in very moderate elevations—averaging around the 500 foot mark, the highest Ozark peaks (between Springfield and Fort Smith) rising not much over 2,000 feet. These exceptional eminences, however, do not come under consideration in this treatise.

Though there are differences in the soils, the greater extremes to affect a flora do not occur in the zone treated. Particularly, there are no considerable areas of sand encountered. We leave the shore of Lake Michigan about Milwaukee and tend westerly making Elgin our next southerly station in preference to Chicago. Hence our zone embraces the early flora of the Chicago region eastward to the lake but does not run farther into the Indiana sand dunes, which it is not desirable to include, for the flora of the sand dunes region presents a problem quite by itself and is worthy of special study.

It is not intended in this limited paper to go into extensive details as to such climatic features as rainfall, temperatures and isotherms.



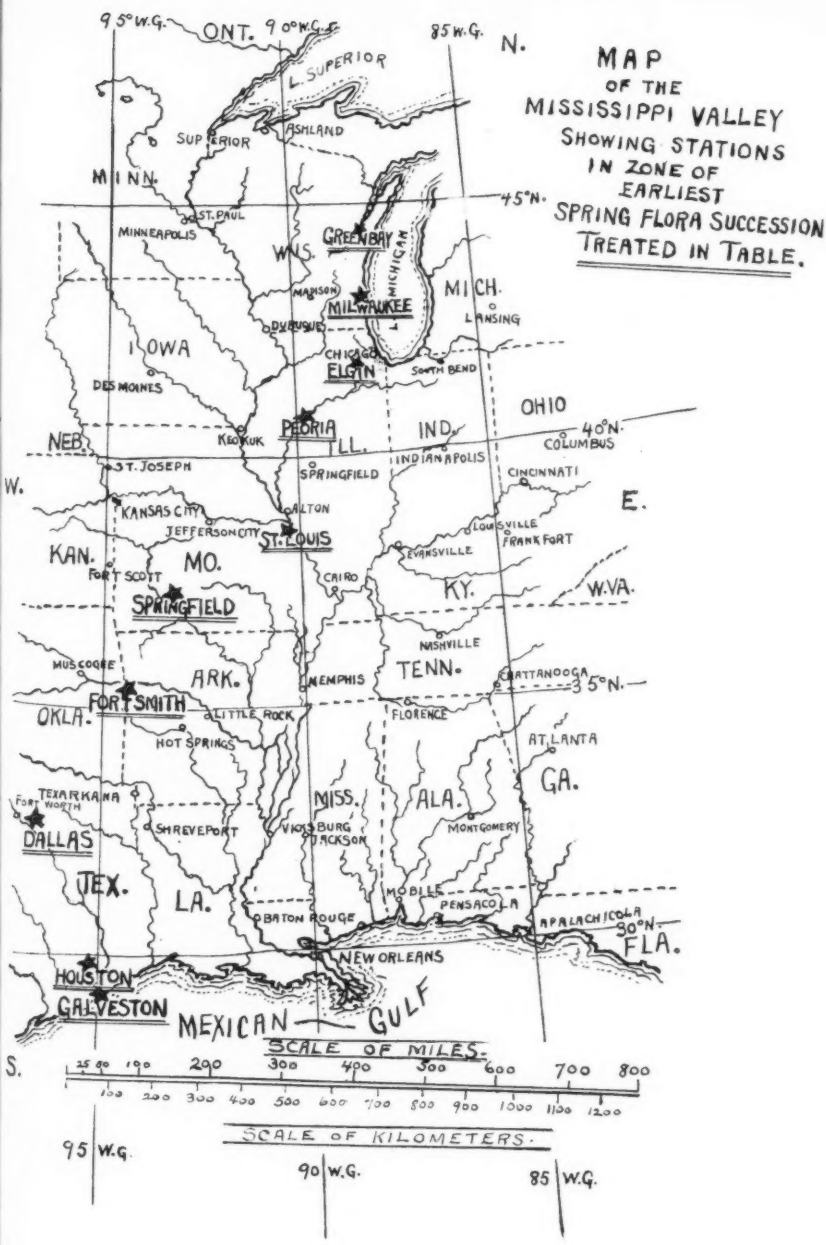

MAP
OF THE
MISSISSIPPI VALLEY
SHOWING STATIONS
IN ZONE OF
EARLIEST
SPRING FLORA SUCCESSION
TREATED IN TABLE.
95° W.G.
ONT.
90° W.G.
85 W.G.
N.
L. SUPERIOR
SUPERIOR
ASHLAND
MINN.
ST. PAUL
MINNEAPOLIS
45° N.
WIS.
GREEN BAY
MICHIGAN
MADISON
MILWAUKEE
MICH.
LANSING
DUBUQUE
IOWA
CHICAGO
ELGIN
SOUTH BEND
DES MOINES
OHIO
NEB.
KEOKUK
PEORIA
ILL.
IND.
40° N.
COLUMBUS
ST. JOSEPH
SPRINGFIELD
INDIANAPOLIS
CINCINNATI
W.
E.
KANSAS CITY
ALTON
JEFFERSON CITY
ST. LOUIS
LOUISVILLE
FRANK FORT
KAN.
MO.
EVANSVILLE
FORT SCOTT
CAIRO
KY.
W.VA.
SPRINGFIELD
NASHVILLE
MUSCOGEE
ARK.
MEMPHIS
TENN.
CHATTANOOGA
35° N.
FORT SMITH
OKLA.
LITTLE ROCK
FLORENCE
HOT SPRINGS
ATLANTA
GA.
TEXARKANA
FORT WORTH
MISS.
ALA.
SHREVEPORT
VICKSBURG
JACKSON
MONTGOMERY
DALLAS
TEX.
LA.
MOBILE
PENSACOLA
BATON ROUGE
APALACHICOLA
30° N.
FLA.
NEW ORLEANS
HOUSTON
GALVESTON
MEXICAN GULF
S.
SCALE OF MILES.
25 50 100 200 300 400 500 600 700 800
100 200 300 400 500 600 700 800 900 1000 1100 1200
SCALE OF KILOMETERS.
95 W.G.
90 W.G.
85 W.G.

Table showing sucession and variation of earliest spring-flowering plants, Over-country Midland, Green Bay, Wisconsin, to Galveston, Texas (excluding most trees and shrubs).

Explanatory: C = common in the given region; F = fairly common; U = uncommon; R = rare.

a, b, c—additional early spring-flowering plants in very limited ranges.

1, 2, 3—to 51—Species treated in Special Notes.

	Regional Center	Approximate Date
1.	Green Bay, Wis.[a]	May 10.
2.	Milwaukee, Wis.	May 1.
3.	Elgin, Ill.	April 25.
4.	Peoria, Ill.	April 20.
5.	St. Louis, Mo.	April 10.
6.	Springfield, Mo.	April 5.
7.	Fort Smith, Ark.	March 25.
8.	Dallas, Tex.	March 20.
9.	Houston, Tex.[b]	March 10.
10.	Galveston, Tex.[c]	March 5.

	1	2	3	4	5	6	7	8	9	10
Poa annua L.[1]					U	U	U	U	F	C
Carex pennsylvanica Lam.	C	C	C	F	F					
Carex siccata Dewey[2]			U	F	F	C	C	F	F	
Spathyema foetida (L.) Raf.[3] (= *Symplocarpus foetidus* [L.] Salisb.)	C	C	F	U						
Tradescantia reflexa Raf.								R	C	R
Tradescantia bracteata Small								U	F	
Nothoscordum striatum (Jacq.) Kunth (= *Nothoscordum bivalve* [L.] Britton)					F	U	F	C	C	C
Erythronium americanum Ker.[4]	C	U	R	R	R					
Erythronium albidum Nutt.	R	U	F	F	C	U	U	U		
Trillium sessile L.[5]				R	R	F	R			
Trillium recurvatum Beck		R	C	F	U	U	U			
Hymenocallis galvestonensis Baker[6] (= *H. occidentalis* [LeConte] Kunth--in part)								R	C	U
Hypoxis hirsuta (L.) Coville[7]					C	F	U	F	U	R
Sisyrinchium gramineum Curtis[8]					U			F	C	F
Sisyrinchium campestre Bicknell			F	F	F	F	U			
Urtica chamaedryoides Pursh								R	C	C
Comandra pallida A. DC.[9]	U	U	C	F	F	C	C	F	U	U
Stellaria media (L.) Cyrill	C	C	C	C	C	C	C	C	C	C
Cerastium vulgatum L.[10] (including *C. viscosum* L.)	C	C	C	C	C	C	C	C	C	C
Claytonia virginica L.[11]	C	F	F	F	C	C	C	C	U	R
Ranunculus abortivus L.	C	C	C	C	C	C	C	C	C	C

	1	2	3	4	5	6	7	8	9	10
Ranunculus Harveyi A. Gray[12]					F	F				
Ranunculus septentrionalis Poir.[13]	C	C	C	C	C	C	F	U	R	
Ranunculus fascicularis Muhl.		R	C	C	C	F	F	U		
Delphinium tricorne Michx.[14]				R	C	U	U	U		
Thalictrum dioicum L.	F	F	U	U	F					
Hepatica americana (DC.) Ker.[15]	C	C	F	U	U	R				
Anemone patens L., var. *Wolfgangiana* (Bess.) Koch[16]					R	R				
Anemone caroliniana Walt.					U	F	F	C	C	F
Anemone quinquefolia L.	C	F	U	U	U					
Isopyrum biternatum (Raf.) T. & G.	U	F	C	C	F	F	U			
Anemonella thalictroides (L.) Spach		R	U	F	F	U	U			
Jeffersonia diphylla (L.) Pers.	F	R	R							
Sanguinaria canadensis L.	C	F	F	F	C	U	U			
Dicentra Cucullaria (L.) Bernh.	F	F	U	U	R	R				
Dicentra canadensis (Goldie) Walt.	F	U			R					
Corydalis aurea Willd.[17]	R	U	R	R	R	U	U	F	F	C
Conringia orientalis (L.) Dumort.		U	U	U	U	U	U			
Draba brachycarpa Nutt.				R	F	C	F			
Draba caroliniana Walt.[18]		R	F	F	F	U	U			
Draba cuneifolia Nutt.					F	F	U	U	U	
Capsella Bursa-pastoris (L.) Medic.	C	C	C	C	C	C	C	C	C	C
Cardamine bulbosa (Screb.) BSP.	C	F	F	U	C	F	F	U	U	
Cardamine bubosa (Screb.) BSP. var. *purpurea* (Torr.) BSP.[19]	C	U	R	R	R					
Dentaria diphylla Michx.	C	F	R							
Dentaria laciniata Muhl.	U	U	F	F	C	F	F	U	U	
Arabis virginica (L.) Trel.				F	F	C	C	C	F	F
Ribes odoratum (Wend.) (= *R. aureum* Pursh)				R	F	F	F	F	F	
Ribes Cynosbati L.[20]	C	C	C	F	F	U				
Fragaria virginiana Duchesne	C	C	C	C	C	U	R	R		
Fragaria vesca L., var. *americana* Porter	C	C	F	U	U	R				
Rubus trivialis Michx.[21]						R	U	F	C	C
Prunus angustifolia Marsh.					R	U	F	F	U	
Prunus americana Marsh.[22]	F	F	F	C	C	C	C	C	F	U
Vicia micrantha Nutt.[23]							U	F	C	C
Lathyrus pusillus L.						U	U	C	C	U
Baptisia bracteata (Muhl.) Ell.[24]							R	U	C	C
Baptisia sphaerocarpa Nutt.							U	F	C	U
Lupinus texensis Hook.[25]								C	F	U
Trifolium repens L.[26]							R	U	F	F
Astragalus mexicanus A. DC.[27]					R	F	C	C	C	F
Astragalus distortus T. & G.					R	C	F	F		
Oxalis violacea L.			U	U	F	C	C	C	C	F

	1	2	3	4	5	6	7	8	9	10
Oxalis europaea Jord.[28] (= *Oxalis corniculata* L. of Gray's Man. 7-Ed. confused with *O. stricta*, not L.)					U	U	F	C	C	C
Geranium carolinianum L.[29]			R	F	F	F	C	C	C	C
Erodium cicutarium (L.) L'Her.				R	U	U	F	U	F	F
Ptelea trifoliata L.						U	U	F	F	
Staphylea trifolia L.				R	U	F	U	U		
Viola cucullata Ait.[30]	F	F	C	C	C	C	C	C	C	C
Viola sororia Willd.	C	C	F	F	U	U	U			
Viola eriocarpa Schwein.[31] (= *Viola scabriuscula* Schwein.)	C	C	C	C	C	C	F	F	U	
Viola Rafinesquii Greene				R	F	C	C	C	U	U
Viola pedata L.					R	U	U			
Viola pedata L., var. *linearíloba* DC.		R	C	F	C	F	U		U	
Viola pedatifida G. Don.			U	U	F	F	F	U		
Dirca palustris L.[32]	C	F	R	R	R					
Oenothera laciniata Hill[33]							U	U	U	U
Oenothera fruticosa L.							U	U	C	R
Oenothera speciosa Nutt.								U	F	C
Panax trifolium L.	C	U								
Adelia acuminata Michx.[34] (= *Forestiera acuminata* Poir.)					R	U	C	U	U	
Zizia aurea (L.) Koch[35]					U	U	C	F	U	
Zizia cordata (Walt.) DC.			F	F	F	U				
Chaerophyllum procumbens (L.) Krantz[36]				R	F	U	F	F	U	U
Epigaea repens L.	R	R								
Androsace occidentalis Pursh				U	C	C	C	U		
Vinca minor L.[37]				R	U	F	F	F	F	F
Chionanthus virginica L.								R	F	
Amsonia Tabernaemontana Walt.					R	R	F	C	R	
Phlox divaricata L.[38]	C	C	F	F	C	C	F	U		
Polemonium reptans L.			R	U	U	F	F			
Ellisia Nyctelea L.[39]				R	F	F	U	U		
Lithospermum angustifolia Michx.				U	U	F	F	C	U	R
Lithospermum canescens (Michx.) Lehm.		R	F	F	C	C	F	U		
Lithospermum arvense L.			R	U	F	U				
Mertensia virginica (L.) DC.				F	F	F	U			
Verbena canadensis (L.) Britton[40]					U	F	F	C	C	C
Scutellaria parvula Michx.							U	F	F	U
Nepeta hederacea (L.) Trevisan[41] (= *Glecoma hederacea* L.)					U	U	F	F	U	U
Lamium amplexicaule L.[42]				R	F	F	F	U	U	U
Lamium purpureum L.				R	R	R				
Salvia lyrata L.							R	R	F	U
Lycium halimifolium Mill.[43]						U	U	U	F	F

	1	2	3	4	5	6	7	8	9	10
Veronica peregrina L.[41]			R	U	C	C	F	F	F	U
Castilleja coccinea (L.) Spreng.							U	C	U	R
Houstonia pusilla Schoepf[45] (= *H. patens* Ell. - in part = *H. patens* Ell. var. *pusilla* Gray, etc.)						F	F	U	C	F
Galium virgatum Nutt.						U	U	F	C	F
Valerianella stenocarpa (Engelm.) Krok.[46]						R	U	U	F	C
Antennaria plantaginifolia (L.) Richards[47]	C	C	C	C	C	C	F	F	U	U
Hymenopappus carolinensis (L.) Porter[48]						R	R	C	U	U
Krigia virginica (L.) Willd.[49]				R	U	F	F	F	U	U
Krigia Dandelion (L.) Nutt.					U	U	F	F	C	F
Taraxacum officinale Weber[50] ?(= *Taraxacum vulgare* [Lam.] Schrank)	C	C	C	C	C	C	C	C	F	U
Sonchus oleraceus L.[51]								U	U	F

ADDITIONAL SPECIES LIMITED AS TO RANGE OR EARLY ANTHESIS

a.—About Green Bay occur the very early flowering but rare species in Compositae, *Petasites palmatus* (Ait.) Gray and *P. sagittatus* (Pursh) Gray.

It is interesting to note that during many years observation, the only few colonies of that very early flowering favorite *Epigaea repens* L. were seen by the author at a very few places near the Green Bay and Milwaukee stations, farthest north in our zone, then again only about Mobile, Alabama, farthest south—this latter station not in the zone under consideration, however.

b.—*Lonicera sempervirens* L., very showy, is of the earliest flowering plants in the woodlands about Houston.

c.—Recently adventitious but already well established and thriving in some places is the *Eschscholtzia californica* Cham. on Galveston Island. From all appearances this plant immigrated through the medium of oil-tankers from the California oil-fields. But for its frail nature and attractiveness tempting its easy destruction, it should hold a promise of becoming a common plant of the region at an early date. Occasional waifs escaping about gardens are not considered here.

Another pretty species in very early flower on the island

is *Modiola caroliniana* (L.) G. Don of the Malvaceae, very common but it does not seem to carry its early-flowering range above the coastal plain of the gulf except as it may appear as an occasional specimen or small colony in favored locations.

Among other very early flowering plants about Galveston and Houston are, *Fumaria officinalis* L., rare; *Coronopus didymus* (L.) Smith, common; *Acacia Farnesiana* Willd., common about Galveston but unusual at Houston (cultivated to some extent) and *Melilotus indica* (L.) All., uncommon at Galveston, rare at Houston.

Parietaria obtusa Rydb., though uncommon at Houston at this season, becomes a common weed southward on Galveston Island. *Cynosciadum pumilum* (Engelm. and Gray) C. & R., uncommon about Galveston, becomes fairly common northward about Houston (locally to Dallas)—*C. pinnatum* DC. replacing it, for the most part northward. A common species about Galveston and coastal is *Hydrocotyle umbellatum* L. The trans-Mississippi Gulf Coast, it may be here mentioned, has other species of Hydrocotyle, in addition. *Anagallis arvensis* L., plentiful about Galveston may also be found occasionally about Houston. *Solanum nigrum* L., fairly common about Galveston becomes unusual at Houston, together with other members of the Solanaceae, as *Physalis pubescens* L. accompanied or locally replaced by other species of the same genus, as *P. lanceolata* Michx. and *P. heterophylla* Nees. These genera in the Solanaceae are late-flowering plants northward. *Linaria canadensis* (L.) Dumont., another summer-flowering plant in the north is common and early blossoming in the coastal reaches occuring as such, locally, northward to Dallas. *Stachys agraria* Cham. & Schlecht. rather rare about Galveston Island, becomes fairly common towards Houston. *Rumex pulcher* L. is one of those plants spasmodically in flower—it probably may be expected in anthesis at any time on the coast, depending on local conditions.

Among the earliest composites common on Galveston Island are *Heterotheca* sp. of which *Heterotheca subaxillaris* (Lam.) Britton & Rusby var. *petiolaris* Benke is a recent de-

termination and *Helianthus petiolaris* Nutt., a summer and fall flowering plant northward, is found in earliest spring anthesis, both at Galveston and Houston. *Erigeron* spp. (including *E. repens* Gray and related variations) about these stations are more abundant than *Helianthus*. Other Compositae noted in earliest spring flower are *Gaillardia pulchella* Foug., *Lactuca* spp., *Senecio vulgaris* L. and *Senecio ampullaceus* Hook., none of which are common plants, however. These composites, for the most part are rather irregular in their periods of anthesis—stragglers may be expected at almost any time on Galveston Island and the lower coastal region.

EARLY-FLOWERING TREES AND CULTIVATED PLANTS NOT TREATED IN THE TABLE

Among the earliest, if not the earliest of all flowers of spring are those overhead in the trees and shrubs. The times of their appearance vary considerably with frost conditions in the atmosphere to which the flora on the ground is not so much subject by reason of various elements of shelter and wind-breaks, such as rocks and cliffs, running springs about, shelter of dead leaves, weeds and grasses and other elements of protection locally at least, none of which are available to the blossoms high up in the air beyond the natural winter protection of their buds. On the other hand, they are under the more direct influence of the sun and the air—favored when of warmer climates. Hence, many of our trees and shrubs are among these very early blooming plants, as elms, poplars, willows, some of the oaks, maples, ash and smaller or lesser trees and shrubs like amelanchier, peach, cercis, sassafras, and cornus in our middle and northerly ranges with camphor, cocos, phoenix and live oak in the southernmost. Simultaneously with our earliest woodland visitors come such cultivated flowers as tulips, daffodils, crocus and hyacinths on the ground and forsythia, flowering-almond and barberry on shrubs and in addition, in the southernmost range, roses, pittosporum, etc., with yucca and certain species of cocos and phoenix higher above ground.

At times when these flowers up in the trees have barely been coaxed out by a warm air-wave from the South-land, a frost will destroy them wholly or in part, when a second blooming period may occur at a later date.

Therefore, we will not include much of this material of trees and shrubs in the table since conditions are so different regarding them, nor can we consider plants in cultivation, except, perhaps as they have escaped and thoroughly established themselves.

COMPARISONS WITH EARLIEST FLORA PARALLELING EAST OF MISSISSIPPI RIVER

The author has also taken a number of trips to the South over south-eastern routes — Tennessee, Kentucky, Georgia, Florida and others directly south down the Mississippi River to the Gulf and yet others, still further east over the Atlantic Coast Plain. Some of the flora under consideration has been found to have a narrow zone while other species extend through an immense range east and west. Among those paralleling their range far to the east, in instances even beyond the Appalachians on the Atlantic plain are the following:

Nothoscordum striatum, Erythronium albidum, Hypoxis hirsuta, Urtica chamaedryoides, Stellaria media, Cerastium vulgatum, Claytonia virginica, Ranunculus abortivus, Ranunculus septentrionalis, Ranunculus fascicularis, Hepatica americana, Isopyrum biternatum, Sanguinaria canadensis, Dicentra Cucullaria, Corydalis aurea, Draba caroliniana, Coronopus didymus, Capsella Bursa-pastoris, Cardamine bulbosa, Dentaria laciniata, Ribes Cynosbati, Fragaria virginiana, Rubus trivialis, Prunus americana, Baptisia bracteata, Trifolium repens, Oxalis europaea, Geranium carolinianum, Viola cucullata, Viola Rafinesquii, Viola eriocarpa, Oenothera speciosa (thoroughly naturalized eastward), *Panax trifolium, Zizia aurea, Chaerophyllum procumbens, Chionanthus virginica, Vinca minor, Lithopermum canescens, Scutellaria parvula, Nepteta hederacea, Lamium amplexicaule, Salvia lyrata, Solanum nigrum, Linaria canadensis, Physalis pubescens* and *P.*

heterophylla, Houstonia pusilla (*H. patens*), *Antennaria plantaginifolia, Krigia virginica, Sonchus oleraceus* and *Taraxacum officinale.*

The fact is that a good share, perhaps most of the species treated in the table occur east of the great river, but in the above list are given the outstanding examples, and it should be noted that those plants which occur as the earliest blooming in the regions west of the Mississippi River also do so in the regions paralleling to the east, often beyond the Alleghenies, with some conspicuous exceptions, however.

On the other hand, we miss a number, either absent, rare, or occurring as a greatly restricted number of species, of the earliest flowers which are found, some of them quite common in the East. As noteworthy among these should be listed:

Azalea, Vaccinium, Asimina, Sarracenia, Crotalaria, Achyranthus, Fothergilla and *Pinguicula* spp.; *Orontium aquaticum* L., *Phlox subulata* L., *Senecio glabellus* Poir., *Calycanthus floridus* L.,*Rosa laevigata* Michx. and *Bignonia capreoleta* L.; *Parthenium Hysterophorus* L. and *Gnaphalium purpureum* L., two species now spreading coast-wise, and *Cornus florida* L. This latter species appears to flower earlier eastward than in localities paralleling to the west, as does another plant, unrelated, *Galium Aparine* L. (var?) of record as early spring-blooming along the Ohio river, but was not observed as such in the zone under consideration. *Serinia oppositifolia* (Raf.) Ktze., *Chrysanthemum Leucanthemum* L. var. *pinnatifidum* LeCoq and LaMotte and *Senecio glabellus* Poir. are other examples of plants blooming earlier east of the Mississippi River than to the west, and so, even if present in our zone, they must needs be omitted from the table.

ASPECT OF ASSOCIATION

The plants of our list, it will be seen, are of the mesophytic association for the greater part. In early spring when the country is just emerging from the winter's cold and snow, the watery soil—water being a slow conductor of heat—has not sufficiently warmed up to bring forth its quota of plants ready to blossom and we can not expect those of the hydro-

phytic association for some days, even weeks, after the plants of the warmer soils, cliff-sides, sunny hills and the deciduous woodlands, which, being yet leafless, allow full sunlight to enter the spaces below. No part of our zone is entirely free from frost, though our southernmost station, Galveston is nearly so.

The rain-fall of the entire region under consideration is moderate, varying in limits not extreme from about 35 inches in the northern and western limits to about 50 inches on the Gulf Coast and this, taken together with the latitude, from 29° 18′ North at Galveston to 44° 32′ North at Green Bay are other factors in maintaining the association of the mesophyte plant species. The range east and west is not so great —from 88° 9′ W. G. at Green Bay to about 96° 45′ W. G. at Dallas.

Were the waters of the Gulf fresh as are those of the Great Lakes we could expect a liberal hydrophytic association of plant life even so early as in the period under discussion, particularly if accompanied by a still greater amount of rainfall—the halophytes being confined to but few species, and sparse. We would then find a vastly richer plant life both in amount and variety about Galveston and yet more so as we approach richer soil like the deltas of considerable rivers—several of them being not too far distant to be considered as influencing the flora of this zone.

For a xerophytic association our zone does not lead us quite far enough west—the rain-fall being too liberal—though we approach its fringes. Yuccas, cacti of considerable luxuriance and desert palm species are already found thriving in the extreme southern district of the zone, approaching Galveston and Houston—edaphic influences playing no small part.

SPECIAL NOTES ON SOME SPECIES

Some plants listed in the table have related species which accompany them or supplant them in parts of the ranges indicated and these are treated in this section under their respective numbers, and certain facts have been observed in field visits about other species which are also deemed worthy of mention in this connection.

1.—*Poa annua** becomes not alone a most early-flowering plant as we proceed southward, but is also extremely common at Galveston, perhaps the most common of all plants there. The species is present throughout the entire zone, but in the north it blooms rather too late to be considered in our list.

2.—In *Carex*, a group of the earliest blooming plants comprise with *C. siccata* as per table, other species, among them *C. stricta* Lam., *C. tetanica* Schkuhr var. *Meadii* (Dewey) Bailey, and in the central reaches *C. varia* Muhl.

3.—*Spathyema foetida* has been collected in flower as early as the month of February about Manitowoc, Wis.—near the Green Bay station of the table.

4.—While *Erythronium americanum* is still common in our northern-most range it soon becomes rare southward. Even at Elgin it is rarely seen while *E. albidum*, rare about Green Bay, becomes very common southward, soon about the only species of the woodlands. At Elgin it is already quite common.

5.—*Trillium* spp. are rather variable in their presentation and are in earliest anthesis, not easily differentiated; for example, *T. sessile* from *T. recurvatum*. In the regions about Peoria and St. Louis, *T. nivale* Riddell is in flower very early.

6.—The coastal plain about Houston is, in places one grand garden, so to speak, of *Hymenocallis galvestonensis* and attracts much attention, particularly from tourists traveling through the region by train or by auto.

7.—*Hypoxis hirsuta* appears more frequent to the east of the Mississippi than westward and seems to come out in bloom relatively earlier. Its range is northward to near Milwaukee but it ceases to be an early blooming plant north of Peoria.

8.—*Sisyrinchium* varies from *S. albidum* Raf., rather local, to *S. gramineum* of very great range reaching even to

* Authority in nomenclature is cited but once, and is not repeated in succeeding references to same species in this paper.

Green Bay, but northerly it cannot qualify as an earliest blooming plant and hence is missing from there in the table. With *S. campestre*, or replacing it, we find *S. albidum* as mentioned before, even in yet earlier flower. Both species, at times, replace *S. gramineum* in the range under consideration.

9.—*Comandra*, like *Sisyrinchium* also varies as to species, in the northern ranges as *C. umbellata* (L.) Nutt., to *C. pallida* in the southern and western.

10.—*Cerastium* occurs both as *C. vulgatum* and *C. viscosum* through the whole area—the latter more evident southward.

11.—*Claytonia virginica* is found to be extremely common in the rich, open soils and is everywhere in given zone an earliest blooming plant. About Fort Smith, Ark., particularly, acres of solid pink were observed, very fascinating in the landscape. The species is remarkable for the great variation in leaf-form, particularly its width, and at the same time an unusual uniformity in the color of the flowers.

12.—*Ranunculus Harveyi*, though occurring about Springfield and St. Louis, was found to be very common only about Rolla, Mo., about midway between the two stations. This locality yielded a new variety, *Ranunculus Harveyi* (A. Gray) Britton var. *pilosus* Benke.

13.—*R. septentrionalis*, also *R. abortivus* are replaced by other species mostly, southward, as *R. micranthus* Nutt., *R. hispidus* Michx., *R. pusillus* Poir. etc.

14.—*Delphinium tricorne* is exceeded in its range southward by *D. carolinianum* Walt., though the former may be expected in earlier anthesis. Other species of *Delphinium* come in later succession.

15.—As to the distinction between the characters of *Hepatica americana* (DC.) Ker. (*H. triloba*, various authors?) and *H. acutiloba* DC., they were usually evident enough for determination, yet some plants were found with leaves both round-lobed and acute on the same plant. This would show that distinction based on leaf-forms may be so confusing as to make a separation of species, variety or form uncertain.

16.—Further in Ranunculaceae, the *Anemone* species as listed, together with *Isopyrum* and *Anemonella* all qualify as earliest-blooming plants both north and south in their respective ranges—at times one genus or species being the *very first* to be seen in blossom, and in other years, another. *Anemone patens* var. *Wolfgangiana* is a rare plant, observed in recent years only about lime-stone bluffs. *Myosurus minimus* L. blooms very early in the middle and southern districts.

17.—A genus varying in narrow but nevertheless distinct limits, widely distributed not only in the zone under consideration, but far to the east and west is *Corydalis*, tending to *C. aurea* (with its var. *occidentalis* Engelm., westward) north and eastward and closely related species—some, perhaps only varietal—as *C. montana* Engelm. and *C. crystallina* Engelm. south and westward.

18.—The earliest *Draba* species vary from *D. caroliniana* in the northerly ranges to *D. cuneifolia* in the middle and southern districts.

19.—Though more common in the north, *Cardamine bulbosa* var. *purpurea* was not observed southward as was *C. bulbosa*. We have a parallel in other Cruciferae, *Dentaria diphylla* of a northern range and *D. laciniata* of a very wide range throughout.

20.—In the south and west *Ribes gracile* Pursh replaces *R. Cynosbati*, the typically northern and eastern plant.

21.—*Rubus trivialis*, extremely common southward, both east and west, becomes rare or entirely absent as the region of heavy frosts is reached.

22.—*Prunas americana* is, perhaps, the most widely distributed of all shrubs or small trees—cosmopolitan in character. It was never absent from any region (of 38 states) visited by the author. On the Gulf Coast occurs a related species, *P. tarda* Sarg.

23.—*Vicia* and *Lathyrus* spp. vary in different regions, but only in the south do they come out as of the earliest flowering plants. In the far south species as *V. Leavenworthii* T. & G. come in with *V. micrantha*, or replace it.

24.—*Baptisia bracteata* and *B. sphaerocarpa* often grow together in the coastal plain and are a charming factor in the early spring landscape, dividing the attention of tourists, by reason of their conspicuous golden-yellow, racemose flowers, with the imposing *Hymenocallis galvestonensis* before alluded to. *B. bracteata* has a range far to the north where it is a summer-flowering plant.

25.—*Lupinus texensis* is the state flower of Texas and justly so, being an earliest spring visitor over the greater part of the state, but particularly of central Texas, where great masses of solid blue can often be seen in every direction.

26.—*Trifolium repens*—an early spring flower of the far south becomes a summer blossom in the northern districts. The same is true of some other Leguminosae as species of *Astragalus* and *Vicia* before mentioned.

27.—*Astragalus mexicanus* has a considerable range as an early flowering plant, but northward occurs rather *A. crassicarpus* Nutt. with it, or alone.

28.—Yellow-flowered *Oxalis* spp. as *O. europaea*, *O. stricta*, etc., are common early blooming plants southward; northward they come into later bloom.

29.—*Geranium carolinianum* is replaced or accompanied by *G. texanum* Heller far southward and so, also, is *Erodium texanum* Gray related to *E. cicutarium*, these ranges being well indicated by their names. *Amsonia Tabernaemontana* and *A. texana* Heller stand in the same relationship.

30.—Several species of *Viola* are very early blooming plants both north and south, but especially in the central regions where the greatest number of species are represented, though the largest colonies are found northward. There is one exception, however, *V. Rafinesquii*. This species is not only extremely early in flower but has a very extensive range in the middle districts and runs far to the eastward, locally being as common as a weed. Somewhere near Peoria the species disappears and is scarcely seen to the north of this station. With *V. cucullata* are allied *V. affinis* LeConte, *V. sororia* and *V. papilionacea* Pursh—not easily distinguished

when young. Southward from St. Louis, it is replaced in the main by *V. missouriensis* Greene. *V. lanceolata* L. also is very early flowering in its range, as are *V. sagittata* Ait. and *V. striata* Ait. It is a very difficult matter to determine ranges in *Viola* species.

31.—In the case of the yellow violets there occurs *V. eriocarpa* through the greatest range, intergrading with *V. pubescens* northward. Occasional white violets may be noted in very early anthesis northward, as *V. pallens* (Banks) Brainerd, or *V. blanda* Willd.

32.—*Dirca palustris* is a northern shrub; when the Illinois line is reached it becomes very rare.

33.—Flowering of *Oenothera* does hardly go by season, being very irregular and can scarcely be tabulated, for various species of this genus may be expected at almost any season, and at different times in different years. Conspicuous examples as observed southward are listed per table. This genus occurs far northward—all through the range—but its species are mostly summer and fall blooming plants.

34.—With *Adelia* (*Forestiera* Poir.) *acuminata* we have *Forestiera pubescens* Nutt., coastal and northward to Dallas.

35.—*Zizia aurea* has at times been noted as the *very earliest* flowering plant of its locality; in other years its blossoming was much delayed..

36.—*Chaerophyllum procumbens* is accompanied by the related species *C. Teinturieri* Hook. in the middle reaches and *C. texanum* C. & R. further south.

37.—*Vinca minor* has so thoroughly established itself over large areas that we must now consider it a part of our flora.

38.—With *Phlox divaricata*, or supplanting it we have *P. bifida* Beck in the central reaches of area treated in table. Far to the south, in Texas we have *P. Drummondii* Hook. in earliest flower.

39.—*Ellisia Nyctelea* is among the earliest flowering plants in the middle ranges of our zone, as is also *Mertensia virginica*.

40.—Hardly is the frost out of the ground when *Verbena canadensis* brightens up the landscape with blotches of purple—and some of roseate hue in about the same proportion as to color as that of a better-known but much later flowering plant, *Aster novae-angliae* L. with its variety (or forma) *roseus*, through all the middle and southern ranges.

41.—*Nepeta hederacea*, like *Vinca minor*, is now thoroughly naturalized throughout our zone, blooming early through most of it.

42.—*Lamium amplexicaule* has a greater range east and west than north and south—particularly to the east.

43.—*Lycium halimifolium* is rapidly establishing itself, especially in the south, though not to a degree with that of *Lonicera japonica* Thund. (a later-flowering plant) which is becoming cosmopolitan, except in the northernmost ranges.

44.—*Veronica peregrina* flowers early southward, and irregularly so, *V. arvensis* L. and *V. serpyllifolia* L.

45.—*Houstonia* spp., mainly *H. pusilla* carpet the ground most beautifully in caerulean blue very early and over a great range, more especially to the east.

46.—*Valerianella* spp. are very difficult to differentiate so early in the season in the absence of the fruit, but the specimens observed were, to all appearances, alike and of the same species, *V. stenocarpa* doubtlessly, further north with *V. radiata* (L.) Dufr. to supplant it.

47.—*Antennaria plantaginifolia* runs through a great range. With it, or replacing it, occur related species, as *A. neglecta* Greene in the central reaches, *A. fallax* Greene (?) southward and *A. neodioica* Greene only in the north.

48.—*Hymenopappus spp.* other than *H. carolinensis*, as *H. corymbosus* T. & G. and *H. tenuifolius* Pursh are summer-flowering plants, except in isolated cases, farthest south.

49.—*Krigia virginica* with *K. amplexicaulis* Nutt., like some other Compositae come into bloom irregularly—usually a few individuals very early with the main anthesis developing some weeks later.

50.—*Taraxacum officinale* becomes unusual in the extreme south about Galveston. The plant has been observed in flower and colected by the author in the region about Elgin, during an unusually mild winter in January, in February and in March,—1921.

51.—With *Sonchus oleraceus* occurs *S. asper* (L.) Hill, and in about the same limited range where early-flowering—northward these species are of summer and fall anthesis.

CHICAGO, ILL.

A NOTE ON ANEMOPSIS CALIFORNICA

LEON KELSO

Anemopsis californica (Nutt.) Hook. Ann. Nat. Hist. 1: 136. 1838;

Writers, in their descriptions of *Anemopsis californica*, have differed as to the pubescence of the plant, when they mentioned it at all. Hooker and Arnott (Bot. Beechey Voyage, 390) do not describe the pubescence but the figure (Tab. xcii) shows a moderately dense, long-villous pubescence on scape and petioles and extending onto the basal margins of the leaves. Nuttall (Ann. Nat. Hist. 1: 136. 1833) describes the scapes and petioles as being pubescent. Casimir De Candolle (Linnaea 37: 333. 1871) described *A. Bolanderi* as glabrous, petioles 8 in. long and sheathing for one-third their length. The same writer (Prodromus xvi[1], 237.) described the leaves of the typical form as ciliolate on the bases and the petioles as pilose. Watson (Geol. Surv. Cal. 2: 78. 1880) says the plant is "more or less floccose".

In August, 1925, the writer found this plant growing abundantly in marshy ground about a pond 2 miles north of Aurora, Colorado. A specimen was sent to Dr. Aven Nelson at the University of Wyoming in 1928. In a letter in reply he noted that the lack of pubescence on the plant might make it worthy of varietal rank.

Examination of the specimens in the U. S. National Herbarium shows the pubescence to be a somewhat inconstant character, varying on leaves of the same plant, and in the species as a whole, from entirely glabrous to a densely crisped floccose pubescence spreading over the faces of the leaves. There is also variation in the robustness of the plant. However, certain degrees of variation seem to be confined to certain parts of its range. Those patches of plants of the typical form, in which robust specimens with a more or less floccose pubescence extending well out onto the face of the leaf occur, are confined to California, parts of Lower California and Nevada.

Anemopsis californica var. **typica** nov. var. Robustior, pubescens, demumque floccosa, laminis foliorum supra subtusque pubescentibus. — California: Laton, edge of sloughs, etc., June, 1901, *Kearney 27;* Santa Barbara, May 1902, *Elmer 3751;* Santa Barbara Co., 1865, *Torrey 471;* Between Santa Barbara and San Juan, 1860-67, *Bolander;* Ft. Tejon and vicinity, 1857-58, *Xantus 109;* Los Angeles Co., low inland meadows, June, 1901, *Braunton 3;* Jacumba Hot Springs, near monument, May 26, 1894, *Schoenfeldt 233;* Ojai and vicinity, May 12, 1866, *Peckham;* 1845-47, *Fremonts Exp.;* In Owens Valley and Ft. Tejon, 1862-64, *Horn;* In very alkaline soil, Temescal Mts., Feb. 1, 1861, *Brewer;* San Bernardino Mountains and their eastern base, June, 1894, *Parish 3160;* Avalon, Sta. Catalina Island, Aug. 1899, *Trask;* San Diego Co., 1875, *Palmer 74;* Ft. Tejon and vicinity, 1857-58, *Xantus;* Los Angeles Co., Ballona creek, near Mesmer, June 12, 1902, *Abrams 2534;* Near San Bernardino, May, 1894, *Parish;* San Diego, May, 1868, *Kellogg and Harford 1141;* S. Cal. to Ariz., June, *Lemmon Herb.;* Sweetwater valley, June 18, 1915, *Collins and Kempton 188;* San Diego Co., mountain spring, May 10, 1894, *Mearns 2992;* San Juan Capistrano, 1912, *Wooton;* Contra Costa, Concord, July, 1903, *Elmer 4870;* San Nicolas Id., April, 1901, *Trask 98;* Sta. Barbara, alt. 5 to 150 meters, July 3, 1913, *A. E. Hitchcock 123;* Pinte Creek, June 6, 1893, *Wilson* (Greene Herb.); San Bernardino Co., May, 1888, *Parish* (G. H.); Vicinity of San Bernardino, alt. 1,000 - 1,500 ft., July 25, 1896, *Parish 4181;* San Bernardino, May, 1880, *Vasey 538;* San Bernardino Valley, August, 1882, *S. B. and W. F. Parish 283.* — Lower California: Nachaguero valley, June 1, 1894, *Mearns 3362;* Sanzal, June 15, 1882, *Fish 261.* — Nevada: Nye Co., Beattie, elev. 3,500 ft., June 5, 1912, *Heller 10,427;* 'Muddy', along streams, May 2, 1902, *Goodding 685;* Lincoln Co., Moapa, May 12, 1905, *Kennedy 1123.*

Those patches the specimens from which are paler and less robust, somewhat glabrate, often glabrous, rarely at all floccose, and never with pubescence widely spreading on the face of the leaf, intergrade with the former variety in California but are the only form found in parts of Lower California,

Mexico, Arizona, Utah, probably parts of Nevada, New Mexico and Colorado.

Anemopsis californica var. **subglabra** nov. var. Minor, non floccosa, rare glabra, laminis foliorum glabris (numquam floccosis). — California: Julian, Cleveland Natl. Forest, July 29-30, 1915, *A. S. Hitchcock;* Salinas valley, May 1, 1861, *Brewer 526;* In brackish marsh, between soda lake and coast, Klamath Valley, alt. 4,200 feet, May 3, 1861, *Cronkhite; Mariposa*, Antioch, July 4, 1902, *Congdon;* Sacramento Valley, *Wilkes-Exp.* — Lower California: Tecate River, near monument, June 23, 1894, *Schoenfeldt 245;* San Jose del Cabo, March 25, 1911, *Rose 16,440;* Mulege, common on moist meadows along stream, May 14, 1921, *Johnston 3692;* San Jaunico, March - June, 1897, *Anthony 420;* Durango Cy., April - November, 1896, *Palmer 118;* Lake Palomas, Mimbres valley, April 14, 1892, *Mearns 166;* Tecate River, June 25, 1894, *Mearns 3784.* — Mexico: Coahuila 111½ miles west of Saltillo, April 22 - 30, 1880, *Palmer;* Ojo Caliente, Zacatecas, May 9, 1892, *Jones 408;* San Luis Potosi, 1879, *Schaffner 240;* Queretaro, 1911 - 13, *Arsene 10,314; 10299;* Sonora, Fronteras, alt. 4550, *Hartman 5;* Feb. - Oct., 1880, *Palmer 1184;* Vicinity of Chihuahua, alt. about 1300 meters, Apr. 8 to 27, 1908, *Palmer 23.* — Arizona: San Pedro, July 20, 1894, *Toumey;* Alkaline swales of Temescal Range, Feb. 1, 1861, *Brewer;* Parker, May 3, 1928, *Thackery 339;* Tucson, May 5, 1892, *Toumey;* May 5, 1894, *Toumey;* Henfords Ranch, San Pedro, July 20, 1894, *Toumey;* Tucson, June 18, 1891, *Dewey;* Tucson, May 26, 1896; *Toumey;* Tucson, 1891, *Neally 48;* Tucson, May 5, 1892, *Toumey 313;* Chiricahua Mts., Reeds Ranch, Cave creek, limestone spring, alt. 5,500 feet, June 28, 1907, *Blumer 1548;* Pima Co., Quitobaquito, Feb. 7, 1894, *Mearns 286;* Sta. Cruz Valley, near Tucson, July 29, 1881, *Pringle 322.* — Utah: St. George, along watercourses and springs, May 2, 1919, *Tidestrom 9246;* St. George, 1869, *Palmer;* 1877, *Palmer 447.* — New Mexico: 3 miles north of Belen, Aug. 2, 1892, *Wooton;* Cieneza Ranch, June 19, 1906, *Wooton 3109;* 4 mi. above Tularosa, Aug. 19, 1907, *Wooton and Standley 3562;* approx. alt. 3850 ft., July, 1906, *Wooton and Standley;* Mogollon Mts., warm spring, Socorro Co., July

6, 1900, *Wooton;* Mangas Sprgs., 18 mi. NW. of Silver City, Grant Co., alt. 4,770 feet, Sept. 2, 1903, *Metcalfe* (Greene Herb.); Mangas Sprgs., Aug. 1901, *Metcalfe;* Ft. Smith to the Rio Grande, Oct. 5, 1853, *Bigelow;* Bean Canon, July 23, 1889, *Munson and Hopkins;* Albuquerque, July 23, 1889, *Munson and Hopkins;* Albuquerque, Aug., 1883, *Rusby 7271;* Aug. 19, 1883, *Rusby 322;* Shalam, approx., alt. 3,850 ft., July 26, 1907, *Foster;* Rincon, May, 1881, *Vasey 278;* Sierra Co., Berendo creek, wet loam, alt. 5,000 ft., May 20, 1904, *Metcalfe 898;* 1851-52, *Wright 1790;* Dog spring, June 13, 1892; *Mearns 314;* Rio Grande, near Mesilla, May 15, 1906, *Standley;* July 18, 1859, *Newberry.* — Colorado: Aurora, 'Bluff lake' 2 mi. north, July 30, 1930, *Kelso 1164* (Type, in U. S. Nat. Herb.).

The writer has had the plants of the type locality under observation for five summers. No floccoseness, or pubescence on the face of the leaf has ever been observed. The more pubescent plants become glabrate in age.

Young or dwarf specimens from California, such as that of *Bolander, Schoenfeldt 233, Parish 3160,* are quite floccose, while *Blumer 1548,* from Arizona, *Mearns 314,* from New Mexico, and small specimens observed in the type locality are almost or entirely glabrous.

I am indebted to Dr. Just for examining the specimens in Dr. Greene's herbarium.

U. S. Biological Survey,
Washington, D. C.

MAMMAL DISTRIBUTION IN SALINE AND CAMDEN COUNTIES, MISSOURI

R. K. ENDERS

As is the case in many of our older and more thickly populated states, Missouri remains relatively unworked by mammalogists. Although the region offers great diversity of topography and habitat, as well as climate, only two papers on the mammals (Jackson, 1906; Schwartz, 1923) have come to the writer's attention during his search of the literature of the region.

The observations on which this report is based were extended over two school years (1928-1930) while the writer was teaching in Marshall, Saline County. Four trips were made into Camden County, two in the fall and two in the spring; but trapping in this county was done on only one trip in the spring.

Saline County lies south of the Missouri River about seventy miles east of Kansas City, near the great bend of the Missouri River. To the north the soil is loess, which grows thinner to the south. All the collecting was done on the loess. This loess supported a prairie with a scattering of trees where this soil was thin and on the banks of streams and in some of the lower lying lands. Most of the land has been under cultivation for many years and the woods have been used as pastures, so natural habitats are limited. The topography is gently rolling.

Camden County, on the other hand, is in the Ozark Plateau, where the soil is thin and the result of the disintegration of the underlying limestone. Some farming is carried on in the valleys, but most of the region is covered by small woody growths of various types. The many limestone cliffs support cedar; the slopes with some soil support several species of hard woods, (oak, walnut, hickory); and the stream valleys support sycamore, elm, and many bushes, with a scattering of hickory and walnut trees also. Ground fires have been frequent on the hillsides so there is little ground cover

or forest litter so essential to a rich fauna. However, in the overflows small bushes and cover are abundant enough to offer protection to a numerous fauna.

Didelphis virginiana: The opossum is abundant in the woods along the water courses and frequently is found about farm buildings. Although they form an important item, possibly the most important from the viewpoint of numbers, in the local fur trade, their numbers are not diminishing to any great extent. Both black and white color phases were collected in Saline County, but the writer did not see any of the brown phase which is reported from Cooper County (Hartman, 1922, pp. 147-148).

Scalopus aquaticus machrinoides: This mole is something of a pest in town where its tunnels disfigure and disturb gardens. Their work is in evidence in most fields where cultivation has not been too frequent. They are abundant in places where there is old sod.

A nest containing five young about an inch in length was discovered by one of my students. It was made of dry grass, dry leaves, and some old paper and was located in a garden in a pile of dirt above the level of the ground. Tunnels led into it from below so the appearance of the pile had not been altered.

A mole was kept in the laboratory for two days during which period no food was offered to it. On the morning of the second day a strong odor of mole pervaded the place and the mole was seen on the surface of the soil searching apparently for food or a means of escape. A dead *Microtus ochrogaster* was placed two inches away from the mole which seized the food at once. With two or three vigorous strokes of the fore feet, which were placed back to back and then separated as in swimming the breast stroke, the skin was reflected from the ventral surface of the abdominal region, while the back of the mouse was held with the mole's teeth. The abdominal viscera were eaten first, the colon and bladder alone being rejected; then the contents of the thorax were attacked and consumed. The whole process was carried out with great energy and with some noise, for the mole made a

sound similar to that made by a suckling puppy. This might have been due to the liquid character of the abdominal and thoracic content.

All of the eating was done on the surface so was clearly observed. Much of the time the mole was on its side with one fore foot against the caudal border of the mouse's ribs, the other firmly planted on the pelvis. At times the mole rolled on its back in its eagerness to get at the organs of the thorax.

After the viscera had been consumed the mole was less frenzied in its eating and started on the flesh covering the bones in the inguinal region. The hind legs of the mouse were spread apart and held by the fore feet of the mole while the flesh was torn and pulled as far as the knee to which the skin had been reflected. The hind quarters finished, the fore quarters were treated similarly, and then the head was attacked. The more massive muscles of the head were eaten before any attempt was made to reach the brain. In accomplishing this the mole showed great vigor in holding the head and considerable impatience in securing the brain which was eaten through the foramen magnum. The brain eaten, the mole turned to gleaning the shreds of flesh that had been left on various bones, all the while making some sound as it ate the flesh from the bones. So far as could be observed no large bones nor the skull were broken, nor was any skin eaten.

The animal did not survive another two day fast.

Cryptotis parva: This small insectivore was found along fence rows, under logs, and one wandered into the laboratory. The invader appeared during the early afternoon of a very cold day when snow covered the ground to a depth of six inches. How it reached the inside of the building could not be determined. Capture was easy, for the shrew could not avoid a hand placed over it, but it did nip the fingers in attempting to escape. It was placed in a cage where it ate raw beef until it escaped, the escape being effected through a very small gap between the wire and frame of the cage.

Blarina brevicauda: This shrew was not so widespread as the smaller *Cryptotis,* but was found in large numbers in

such habitats where it did occur. It was partial to moist lands where down logs were abundant, as many as three being taken in one day from under one log. Associated with it were *M. ochrogaster* and two species of *Peromyscus: P. l. noveboracensis* and *P. n. aureolus.*

Myotis lucifugus: Little brown bats were found in the tower of a building in Marshall.

Nycteris borealis: One red bat was captured in a sparrow trap in Saline County.

Procyon lotor: This fur bearer was reported from the more extensive bottom lands in Saline County, where it is hunted and trapped, forming an important item in the local fur trade.

Spilogale interrupta: A student reported the killing of a little spotted skunk that had been about his farm buildings. There is no doubt in my mind as to the generic identification.

Mephitis mesomelas: This species was identified from specimens picked up along the road where they had been killed by passing automobiles.

Vulpus fulva, Urocyon cinereoargenteus: Although the writer heard foxes barking frequently in Camden County and although his dog would chase them, they were never well enough seen to identify with any degree of satisfaction.

Canis latrans: The coyote is a nuisance in Saline County for he will take lambs, small pigs, or poultry, although he is blamed for much harm this is done by other animals. Thus, damage done by dogs is sometimes blamed on the coyote, no one appearing to have a good word for him.

During 1928 Saline County paid bounties on thirty-eight adults and twenty-nine pups; in April, 1930, this county paid bounties on twenty-eight, mostly pups. One man dug out a den containing nine pups.

One day a farmer living near the city attempted to drive sheep into one corner of the field preparatory to separating them. The sheep refused to go. Investigation disclosed the presence of a "wolf" in a nearby thicket. Although this an-

imal was seen several times, efforts to kill it were unsuccessful.

Marmota monax: Just one specimen of this species was secured in Saline County where it was not abundant. Many were seen near Fortuna, Moniteau County, and one was reported from Hahatonka. As it prefers a locality where its burrows are not constantly disturbed by cultivation, such a distribution is to be expected.

Citellus tridecemlineatus: These mammals were abundant in an unused corner of the campus in the fall of 1928. Next fall none were to be secured even by advertising in the local paper, as they had apparently disappeared during the spring and early summer of 1929. None were seen in the spring of 1930.

Sciurus niger rufiventer: The fox squirrel was present in the older portions of the city where the shade trees were large, and it was fairly abundant in the woods of Saline County. Many nests of leaves were observed in the woods in Camden County. They were abundant on the sparsely wooded hillsides where they took to the ground in travelling from tree to tree.

Sciurus carolinensis: The grey squirrel was abundant in heavy timber in Camden County, but was replaced by the fox squirrel where the forest was more open.

Geomys bursarius: A specimen of this species of pocket gopher taken in northwestern Saline County was in the college museum at Marshall. Burrows were seen elsewhere in the county, but the writer took no specimens.

Reithrodontomys megalotis dychei: This harvest mouse was found in a field which had been planted with sweet clover the year before, but not cut. Here the animal was found associated with *P. m. bairdii* and *S. a. machrinoides.* Constant trapping in undisturbed prairie-like habitats did not yield this mouse.

Peromyscus maniculatus bairdii: The prairie deer mouse was abundant in Saline County, but absent in Camden County. In the blue grass they were outnumbered by *M. ochrogaster,*

while in cultivated fields they were the most numerous mammal captured.

Peromyscus leucopus noveboracensis: The forest deer mouse was very abundant in both counties. In Saline County it was found in the hedge rows, in the woods, and along the streams where there was brush or stumps. The frequent ground fires in Camden County woods appeared to have kept down the numbers there for the mouse was rare in the burned over areas. It was nevertheless abundant in the moist, low lying woods that were undisturbed by fire.

Peromyscus nutalli aureolus: One specimen of this beautiful deer mouse was taken on a rocky hillside in Camden County.

Synaptomys helaletes gossii: Two specimens of the lemming vole were taken, both of them in a basement where they had wandered. The fact that potatoes were stored there did not, in my estimation, have anything to do with the presence of mice, as they were obviously just wandering about in a haphazard fashion.

Microtus pennsylvanicus: The only specimen of this species examined was found on a bright afternoon at 2:40 in the coils of a large black snake. The capture had just taken place for the snake was attempting to maneuver the head of the mouse into position for swallowing. It appeared that the snake had struck the mouse on the right hind leg as it ran along a well defined runway, and had then thrown his coils about the victim. The swallowing was begun while the mouse was held tightly in the coils. What appeared to be this field mouse was abundant about some hay stacks in the fields.

Microtus ochrogaster: This mouse was very abundant at times and in certain places. In early spring large numbers were taken in a field in Saline County which is said to have the undisturbed original sod. Here it was the most abundant mammal. In May live traps placed in the same field were unproductive. In Camden County they were encountered in the over-flow bottoms where there was a rich growth of grass between the piles of driftwood.

Pitymys nemoralis: The pine mouse was common in the woods in both Saline and Camden Counties. Trapping for this mouse is best carried on at some depth under logs and with a meat bait, as it is highly carnivorous if one may judge by the mutilated specimens found where they are abundant.

Ondatra zibethica: This mammal was common wherever habitat conditions were favorable and there was not too much trapping.

Mus musculus: This pest is abundant in the gardens in Marshall as well as in some fields. In one blue grass patch eight were taken before other forms would enter the traps.

Lepus townsendii campestris: The white tailed jack rabbit is fairly abundant in certain portions of Saline County. A group of young were seen at the local airport. One field where hay had been piled into gullies to prevent erosion, appeared to be the center of abundance. The rabbits had "burrows" through the hay that were used as retreats. In this connection it might well be well to state that a pair of great horned owls were frequently seen here and a young one captured.

Lepus californicus melanotis: Schwarz (1920, p. 43) reports this rabbit as occupying the prairie regions of the western part of the state. One specimen was found in Saline County, but it offered an excellent opportunity for study through binoculars, so that there was no possibility of mistake in identification.

Sylvilagus floridanus mearnsii: This rabbit occurs in the fields, hedge rows, and the woods, while the jack rabbit is confined to the large open fields. During the severe winter of 1929-1930 this rabbit was hard pressed for food, attacking even the bark of trees and shrubs. Wild rose and cherry, as well as hawthorne, suffered from their attacks.

Sylvilagus bears its young in nests in shallow depressions. One such nest was six inches in diameter and five and one-half inches deep, the cavity being lined with fur. It was located on level ground and gave the impression that it had been dug although no loose material could be found. Young

were found in such nests from April 17 until field work was suspended in June.

HABITATS

Saline County:
- Prairie
- Forest
- Old field
- Aerial

Camden County:
- Forest
- Overflow forest

Prairie

Scalopus aquaticus machrinoides. Workings.
Cryptotis parva. Two
Mephitis mesomelas. Seen.
Canis latrans. Reported.
Citellus tridecemlineatus. Seen.
Geomys bursarius. Workings.
Peromyscus m. bairdii. Six.
Synaptomys helaletes gossii. Two.
Microtus ochrogaster. Twenty-two.
Mus musculus. Eight.
Sylvilagus f. mearnsii. Two.

Unmodified prairie is very difficult to find in Saline County. One small area of unbroken prairie was studies intensely. This area lay on either side of a small stream along which grew some small trees. The sod was thick and supported a rank growth of grass, chiefly blue grass. Although stock could reach the plot, the grass was long and fell over the numerous runways that penetrated the tangle.

Forest

Didelphis virginiana. Reported.
Cryptotis parva. One.
Procyon lotor. Reported.
Sciurus n. rifiventer. Two.
Peromyscus l. noveboracensis. Twelve.

Pitymys nemoralis. Three.
Sylvilagus f. mearnsii. Two.

This forest was not extensive nor was it primitive by any means. Stock grazed in it, and the more desirable trees had been removed. There was little or no forest litter and few logs, which accounts, probably, for the limited fauna.

Old Field

Scalopus a. machrinoides. One.
Citellus tridecemlineatus. Seen.
Reithrodontomys m. dychei. Three.
Peromyscus m. bairdii. Five.
Microtus pennsylvanicus. One.
Lepus t. campestris. Nest with young.
Lepus c. melanotis. One.

The year before the one in which this work was done this field had been planted in sweet clover but the crop had not been cut. The stout stems formed a good cover, but no runways were found. Apparently *R. m. dychei* and *P. m. bairdii* lived in holes in the ground, as they were taken in traps set at the mouth of the holes.

Aerial

Myotis lucifugus.
Nycteris borealis.

Forest

Blarina brevicauda. One.
Vulpes fulva. Seen.
Urocyon cinereoargenteus. Seen.
Marmota monax. Seen.
Sciurus carolinensis. Seen.
Peromyscus l. noveboracensis. One.
Peromyscus n. aureolus. One.
Pitymys nemoralis. Three.

This forest was located on a rock hillside along the lake and stream of Hahatonka Spring. The hillside was steep with rock occurring in parallel outcroppings. The trees were mixed

hardwoods, mostly oak (*Quercus* spp). As ground fires were of almost annual occurrence there was little litter or ground cover and few logs. Even the vernal flora was very poor. An extensive line of traps was remarkably unproductive.

Overflow forest

Blarina brevicauda. Eleven.
Procyon lotor. Tracks.
Sciurus n. rufiventer. Seen.
Peromyscus l. noveboracensis. Ten.
Microtus ochrogaster. Fifteen.
Sylvilagus f. mearnsii. Seen.

This tract was located between the Niangua River and the mouth of the stream from Hahatonka Spring. The trees were elm (*Ulmus* sp.), with some sycamore along the stream and a scattering of walnut and hickory trees. Patches of grass were found in the more open places. Piles of logs, driftwood, and other stuff brought down by the river and lodged against the trees occurred as disconnected masses usually a hundred or more feet apart. It was in these masses that the traps were set.

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THE BADGER TAXIDEA TAXUS (SCHREBER), IN INDIANA*

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Apparently Badgers have never been common in Indiana or the two adjacent states, Michigan and Ohio, which are the eastern limits of their range. Dr. Elliott Coues[1], writes, "The eastern range in the United States to Ohio, Indiana, Illinois, Michigan, Iowa and Minnesota, as well as the oblique trend in British America to Hudson's Bay, thus makes the distribution of the animals more or less closely coincident with that of some of the Spermophiles; these animals with the Badger and Kit Fox, being highly characteristic species of the central treeless region of the United States, where they occur in countless multitudes." Similar remarks are made by A. M. Brayton[2]. No Indiana specimens are mentioned by them, but these are the earliest published statements of Badgers in Indiana that have come to my attention.

More modern authors, Hahn[3], Evermann and Clark[4], have been inclined to the belief that the Badger in Indiana is extinct, or nearly so. As several recent records authenticated by specimens or photographs, have come to my attention in the last few years it seems desirable to publish them along with the earlier records.

The next earliest reference that I have, after those of Coues and Brayton, is Dinwiddie[5] who writes regarding Lake County, "Badgers and Hedgehogs [Porcupines] have never been very numerous and are almost extinct here."

Evermann and Butler[6], in 1894, report the occurrence of Badgers in the following counties and years: Vermillion, 1880; LaGrange, 1887; Franklin, 1889; Noble, 1880, Steuben, DeKalb, Kosciusko, Grant (?), dates not given. The next year Butler[7] says Badgers are occasionally found in Newton

* Paper read at Fourteenth Annual Stated Meeting of the American Society of Mammalogists, U. S. National Museum, Washington, D. C., May 4, 1932.

County and that one was killed in Benton County in 1874.

Hahn[3] reports Badgers as occurring in Noble County, 1895; at English Lake, La Porte County, 1871; Lagrange County, 1908; and mentions their occurrence in Benton County probably at the time of writing.

Evermann and Clark[4] write, "Various old residents say that it was formerly found in Marshall County."

George A. Brennan[5], page 254, records in considerable detail, seeing, in November, 1918, a Badger near Furnessville Blowout of the Indiana dunes. This is now in the west portion of the Dunes State Park. When I published a list[6] of the mammals of the Dune region of Porter County, I referred to the possibility of Badgers being found there, but was unable to secure any definite information.

Within the past five or six years my attention has been brought to several additional records.

The Indianapolis Times of November 29, 1926, records a 16 pound Badger captured by Kenneth Solt, of Columbia City, Whitley County. The Indianapolis Star, Sunday, Feb. 27, 1927, had in the illustrated section, an excellent picture of a young Badger caught in Lake County. I am indebted to Dr. Amos W. Butler for calling my attention to these notices.

Col. Richard Lieber, Director, Department of Conservation, secured the name and address of the photographer (J. G. Allen, West Lafayette) of the last mentioned record and obtained for the Department of Conservation a copy of the original photograph of the Lake County Badger. In addition, he secured a photograph, also by Mr. Allen, of two young Badgers that had been dug out of their den in Porter County.

In July, 1930, Mr. Frank Brown, of Carr Lake, Claypool, Kosciusko County, captured a Badger and made a snapshot of it and let me have a copy. Mr. Brown at the time was setting traps in what he supposed were Woodchuck burrows in order to catch Woodchucks for some summer residents who wished them for eating purposes. The skin was saved, but the skull and carcass thrown away before I learned about the incident. Mr. Brown was tremendously surprised when he found what he had captured in his traps.

In 1929, Mr. C. S. Robbins, a taxidermist west of South

Map of Indiana, showing the known distribution of the Badger, *Taxidea taxus* (Schreber), by counties. Figures are years when reported by various authors, including the present writer; P, record published without date; Ph C, photograph owned by Department of Conservation, Richard Lieber, director; Ph L, photograph in possession of the writer; N, skull in United States National Museum; ?, unverified record or probable date of record.

Bend, told me of a badger that had been killed near U. S. Route 31, in the southern part of St. Joseph County. He had preserved the skin of the animal for its captor and was kind enough to give the skull to the U. S. National Museum. This is the only specimen of an Indiana Badger in a museum.

In August, 1930, about one and one-half miles north of New Carlisle, St. Joseph County, Mr. Fred Predmore, of the Smoger Lumber Company, South Bend, and two companions, saw two Badgers on the highway leading north to Galien, Michigan. They jumped out of their car and one of the animals was killed with a club while the other escaped. The captured specimen was mounted by a local taxidermist and after being on display at the Smoger Lumber Company was sold to a Chicago salesman. A brief account of this animal was printed in the South Bend News-Times of Aug. 6, 1930. One of Mr. Predmore's companions is shown holding the dead animal, but the latter is unidentifiable in the newspaper picture as a Badger.

In October, 1930, Mr. William L. Engels, of the University of Notre Dame, learned of a Badger being killed by a motor car, near Elkhart. The specimen was mounted and is owned by Mr. Elmer Wambaugh of Elkhart. It is a large male and Mr. Engels obtained these measurements from the mounted skin: head and body, 860 mm.; tail, 143 mm.; hindfoot, 125 mm. Mr. C. S. Robbins, the taxidermist, thinks he mounted this specimen and he was given to understand that the badger was run down just over the Elkhart County line in Michigan. Mr. Robbins can establish a certain recent record of the Badger in Elkhart County, however, for he mounted another specimen killed near Goshen, in the autumn of 1931.

Levin Brothers, dealers in furs, hides, etc., Warsaw, Kosciusko County, told me that during the winter of 1929-30 three Badger skins were offered them for sale by local trappers.

The proprietor of a pool room in Royal Center, Cass County, told Mr. William L. Engels and me that a Badger had been killed nearby in 1930-1931 and that he knew of another that had been killed in Jasper County the same season.

PLATE XI.

Badger caught by Mr. Frank Brown, Carr Lake, Claypool, Kosciusko County, Indiana, July, 1930.

He seemed to be well posted on animals and to know about what he was talking*.

In spite of the density of population and intensity of farming in northern Indiana, Badgers are still occasionally found. They are conspicuous animals and quickly set upon and usually killed when met with. The present day records are based upon one skull from St. Joseph County in the U. S. National Museum, photographs of specimens in Lake and Porter Counties, owned by the Department of Conservation, and a snapshot in my possession of a specimen captured in Kosciusko County and various well authenticated records.

* In his place he had a case of stuffed birds and mammals to which he had fallen heir when he acquired the pool room. The greater part of the case is occupied by a stuffed Virginia Deer that had been killed near Royal Center about 50 years ago. It was a female and possessed small spike antlers. A nearly mature fetus was inside when killed. The latter was also mounted and is in the same show case with its mother.

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South Bend, Ind.

SPIRIFER ORGANENSIS SHUMARD

D. K. GREGER

Spirifer organensis Shumard

Plate XIV—Figures 1-4.

The material on which this species is based was collected by Dr. G. G. Shumard in December, 1855, from Pennsylvanian rocks in the Organ Mountains northeast of the present town of Mesquite, Dona Ana County, New Mexico.

Dr. G. G. Shumard was surgeon and geologist to the expedition of Captain John Pope, U. S. Corps of Topographic Engineers during the U. S. government investigation of the possibility of obtaining water by means of artesian wells in the region between the Red River and the Rio Grande along the 32nd parallel.

The fossils collected on the expedition were turned over to his brother, B. F. Shumard, for identification and description; the description of *Spirifer organensis*, however, was not published until 1868 and then without figures.

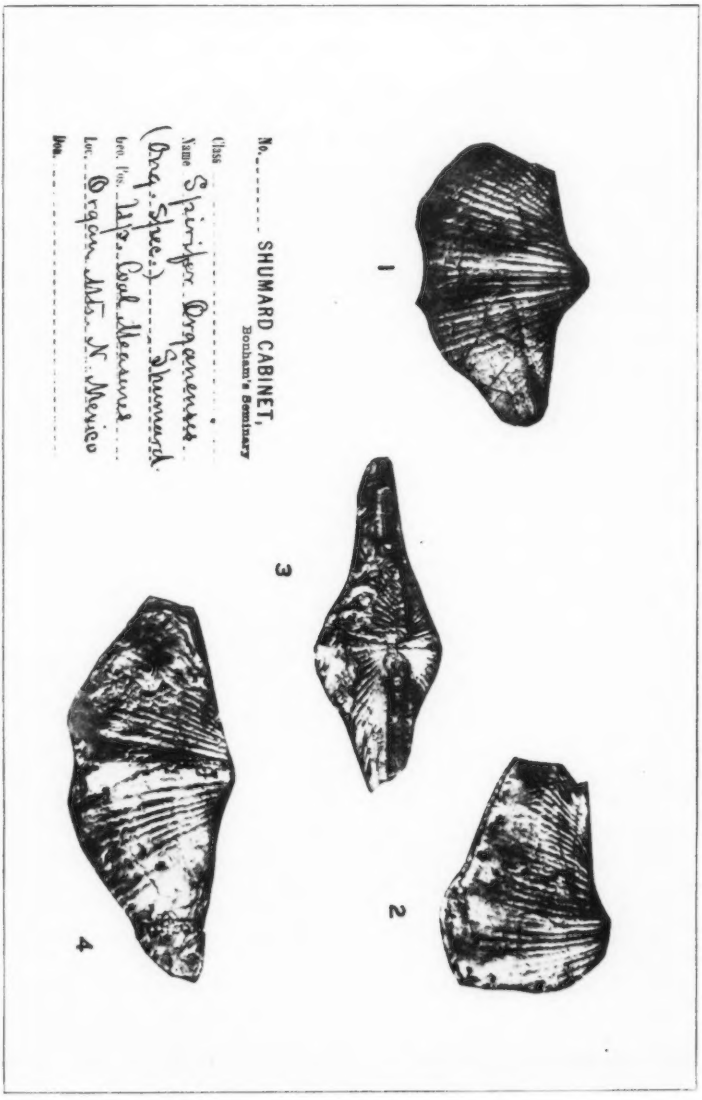
In the remnant of Shumard's collection, preserved in the cabinets of Washington University, there is a box (No. 720001 Syst. Coll.) containing seven specimens of this species accompanied by a Shumard label, the lot being designated as "orig. spec.".

From this lot I have selected four specimens which are figured on the accompanying plate, along with republication of the original description.

1868—*Spirifer organensis* Shumard, Trans. Acad. Sci., St. Louis, Vol. 2, page 108 (read 1862).

Original description: "Shell of medium size, semielliptical, very transverse, width about double the length; thickness somewhat more than half the length; hinge line extended and terminating in acute points: lateral margins very gently arched from the cardinal angle to the front, which is excavated at the mesial elevation. Ventral valve gently and regularly convex, sinus moder-

PLATE XII.


No. SHUMARD CABINET,
Class
Name Spiriferina Oregonensis
(Arq. Shum.) Shumard
Geol. Pos. Upper Coal Measures
Loc. Oregon, Miss. N. Mexico
Don.
1
2
3
4

ately excavated, gradually increasing in width to the front, and marked with seven or eight small, rounded costæ, of which the median one is simple, while the others are derived from the trichotomizing of two which originate one on each side of the beak; area narrow, slightly concave, terminating at the extremities in very acute angles, deltoid opening rather large, and forming almost an equilateral triangle; beak small, moderately elevated, and overhanging that of the opposite valve. Dorsal valve less convex than the ventral, flattened on each side of the mesial elevation, which latter is but little elevated, rounded, expands rapidly towards the front, and is limited by curvilinear margins. Surface marked with small, rounded costæ, of which those on the sides bifurcate near the cardinal edge, and thence usually continue without further division to the front margin, where, in the specimens before us, we can count from 20-22 on each side of the mesial fold and sinus; those which originate at the beak are disposed in two fasciculi of three or four costæ each; the surface is also covered with extremely fine waved lines of growth.

Dimensions: Length, .95 inch; width, 2.10 inches.

A closely related, if not conspecific species, occurs in a collection of Bolivian, Pennsylvanian fossils. This latter is the *Spirifer condor* d'Orbigny[1]. Elsewhere, I have[2] identified d'Orbigny's species as occurring in our western Pennsylvanian faunas; however, I feel that it is best to designate our North American species as *Spirifer organensis* Shumard, rather than *Spirifer condor* d'Orbigny. The species here referred to is abundant in the Deese member of the Glenn Formation, I felt that the identification with the South American species was closer than with any North American species with which I was familiar at that time.

[1] Spirifer condor d'Orbigny, 1842: Voyage Dans l'Amerique Meridionale Pal. p. 46, pl. 5, figs. 11-14.

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FOSSIL OPERCULA FROM THE KNOX DOLOMITE[1]

CHARLES R. L. ODER

INTRODUCTION AND ACKNOWLEDGMENTS

During the summers of 1930 and 1931 the writer was employed by the Tennessee Geological Survey in mapping and subdividing the Knox Dolomite in the Valley region of eastern Tennessee. Materials for the preparation of this paper were gathered while performing that work.

Aside from the Cambro-Ordovician boundary, the Knox beds have long proved difficult to stratigraphers owing to the pronounced lithologic similarity of the various units, and the rarity and inaccessibility of fossils. Field activity has revealed a greater faunal variety than was hitherto believed to exist, and many of the fossils are so restricted vertically as to be of primary stratigraphic value. Their occurrence in chert and the fact that they are seldom taken "in place" hinders a ready utilization as horizon markers. Nevertheless, the exact position in the section has been fixed for a considerable number of species.

Among the least known, yet some of the most common and interesting fossils found in the Knox, are the opercula of ancient and unknown gastropods. These forms are usually silicified, and fall from the limestones and dolomites into the residual soil, not far removed from their original position in the strata. This paper is designed to outline the morphology of these shells, to denote their stratigraphic position, and to describe one new genus and nine new species of the genus *Ceratopea* Ulrich.

The author wishes to express his gratitude to Mr. Walter F. Pond, State Geologist of Tennessee, who supplied every need for efficient field work and freely gave permission for publication; and to Dr. T. E. Savage, of the University of Illinois, who offered generous encouragement during the study, aided in matters of interpretation, and criticized the completed manuscript.

[1] Published by permission of the Tennessee Geological Survey.

I. MORPHOLOGY AND TERMINOLOGY

The operculum of modern gastropods is a horny or calcareous, more or less flat, lid-like process secreted by and attached to the posterior dorsal surface of the foot. It serves as an apertural cover when the animal is retracted. It is largely restricted to the Prosobranchiata, being somewhat rare in the Opisthobranchiata or Pulmonata. The manner of preservation and the thickness of the opercula here discussed point to their original calcareous nature.

This portion of the univalve shell has not received wide treatment by paleontologists. In 1842 Woodward[2] included a generalized description of the operculum in listing the generic characters of *Maclurea*. Salter[3] described the operculum of *Maclurea logani* in some detail and gave some very helpful figures, showing the operculum oriented in the shell. Billings[4] figured and discussed three opercula of unknown species of *Maclurea*, applying two new specific names on the basis of these opercula. Bassler[5], in 1909, figured a specimen of the type of operculum we are here concerned with, and pronounced it that of an unknown gastropod, suggesting the probability of its belonging to the genus *Maclurea*. E. O. Ulrich[6], realizing that this perculum would not fit the shell of a true *Maclurites* nor of any other known univalve, applied to it the new generic name *Ceratopea*.

Many workers have dealt with opercula of *Maclurites*, and detailed description was unnecessary. Rocks yielding the forms presented here have been pretty thoroughly searched over a period of years, yet the complete shells have not been discovered. Since this is true, and because these fossils have stratigraphic value, it seems desirable to designate them by names and to publish descriptions.

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[2] Manual of Mollusca, p. 202, 1842.

[3] Can. Org. Remains, Decade 1, Geol. Surv. Can., p. 8, pl. 1, figs. 2-6, 1859.

[4] Pal. Foss. Can, vol. 1, p. 243, figs. 228-230, 1861-1865.

[5] Va. Geol. Surv. Bul. II-A, pl. 20, fig. 3, 1909.

[6] Bul. Geol. Soc. Am., vol. 22, p. 665, 1911.

For the proper description of these opercula definite morphological terms were needed. Hence, the writer presents a terminology, with figures illustrating the meaning of the terms employed. These designations have been especially used for characters which seem to have taxonomic value.

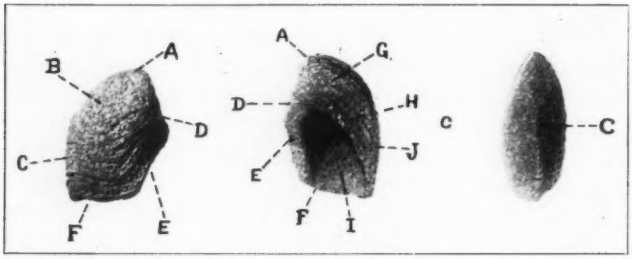
Orientation of the operculum in the shell indicates that the broadest portion is always uppermost, and that when the shell is closed it lies above the next largest division from which it is separated by a sharp carina. This larger, more convex area is called the dorsal surface and that area which lies beneath it when placed in the shell will be referred to as the ventral surface.

Most of the opercula approximate a conical outline. Former investigators recognized the fact that growth started at the summit of the cone-like structure and called this the nucleus. Nuclear apex is here used for the tip of the nucleus because in different species its form and position vary considerably.

The operculum is oriented for description by holding the nuclear apex uppermost. This brings the dorsal surface into the foreground and gives right and left sides, the left side being bounded by the dorso-ventral carina which separates the dorsal and ventral surfaces. Characters mentioned above are shown in Figure 1.

Features best seen on the ventral surface are shown in Figure 2. The opercular rim is the more or less sinuous basal margin of the operculum which surrounds the opercular muscle cavity. It is the portion of the operculum which actually came into contact with the apertural margin of the shell. That part of the opercular rim which adjoined the inner lip of the shell is named the inner opercular margin. The outer opercular margin formed the junction of the operculum with the shell along its outer lip. The posterior opercular margin is that part of the opercular rim which fitted against the outer, lower end of the aperture. The anterior opercular margin lies above and forward of the posterior one. The ventral surface occupies

the space beneath the nuclear apex and the dorso-ventral carina, and above the opercular rim.



TERMINOLOGY OF THE MACLURITOID OPERCULUM

Fig. 1. Dorsal view. A, nuclear apex; B, dorsal surface; C, dorso-ventral carina; D, anterior opercular margin; E, inner opercular margin; F, posterior opercular margin.

Fig. 2. Ventral view. G, ventral surface; H, opercular rim; I, opercular muscle cavity; J, outer opercular margin.

Fig. 3. Carinal view. C, dorso-ventral carina.

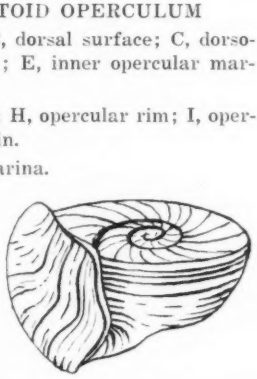


Fig. 4. Operculum oriented in the aperture of the gastropod shell.

Figure 4 is a hypothetical orientation of the operculum in the gastropod shell. It is seen that in this position the operculum is wholly free from contact with the shell except along the peristomial margin. This accounts for the continuation of the growth lines across the ventral surface of the operculum. This orientation affords some idea of the type of aperture possessed by *Maclurites* as compared to the shells to which the forms called *Ceratopea* belonged. In *Ceratopea* the nuclear apex must have projected slightly above the upper margin of the peristome and the opercular rim fitted against the

peristomial margin instead of being drawn within this border when the shell was closed. Neither of these conditions obtained in *Maclurites*. Again, the outline of the opercular rim indicates an aperture for *Ceratopea* which differed widely in shape from that of *Maclurites*. On the other hand, the shape of the aperture called for in the orientation of these opercula indicates a shell of the Macluritoid type and, on consideration of the great similarity which must have existed in these two forms, it seems likely that *Ceratopea* may have been directly ancestral to *Maclurites*.

In the new genus *Pondia there is no* dorso-ventral carina, and the ventral surface is simply a narrow, subtriangular area beneath the apex. The opercular rim is merely a thin border, without undulations at the junctions of the operculum with the inner and outer lips. Thus, it is easily seen that the shell to which this operculum belonged possessed a distinctly different type of aperture and possibly belongs to a different family. However, since the family Macluritidae (Macluriidae of Woodward) rests on somewhat uncertain ground, and as only two specimens of *Pondia* are known at present, it appears advisable to leave them in this category.

II. GEOGRAPHIC AND GEOLOGIC DISTRIBUTION

Ulrich states that the *Ceratopea* type of operculum has been collected in Pennsylvania, Virginia, central Texas, Arkansas, Oklahoma and Missouri. Rocks of the same age, bearing similar faunas, occur in Wisconsin, Minnesota and Iowa; but it is not known that the forms of operculum here described have been discovered in those states. The opercula of *Maclurites affinis*, from Newfoundland, figured by Billings, seem to have come from Chazyan strata, and to be different generic types from the true *Ceratopea*. However, Billings referred them to the genus *Maclurea*, or *Maclurites*.

All of the writer's specimens of *Ceratopea* come from Lower Ordovician horizons, referred to portions of two formations of the Canadian or Beekmantown divisions of that period in Tennessee. These species are distributed between

two beds for which Missouri names are provisionally used. The Tennessee rocks equivalent to the Jefferson City formation of Missouri are less doubtful than those that correspond to the Cotter above. It appears likely that the strata above the Jefferson City in Tennessee may eventually be found to contain elements of both the Cotter and Powell formations of Missouri, but exact correlations are not easily made.

According to Ulrich, *Ceratopea keithi* occurs abundantly in the lower middle part of the Arbuckle limestone in the Wichita uplift of south-western Oklahoma. He reports other species as common in the Yellville formation of Arkansas, in somewhat similar stratigraphic horizons in Missouri, and in the Beekmantown beds of Pennsylvania and Virginia.

Pondia powelii was found in the Jonesboro limestone, which marks the top of the Cambrian in Tennessee: but the exact level from which it comes is uncertain. It probably occupies about the position of the Copper Ridge dolomite of the southern Appalachian Valley, which is roughly equivalent to the Conococheague formation of Maryland and the Eminence formation of Missouri. Whether the Jonesboro is younger than the Copper Ridge or of contemporaneous deposition remains to be settled. So far as the writer has been able to ascertain, the two have not been found together in any locality, and some very characteristic fossils, such as a certain species of *Cryptozoon*, which are considered to be more or less restricted to the Copper Ridge have been collected from both beds.

This genus is named for Mr. Walter F. Pond, State Geologist of Tennessee, and the specific designation is adopted from the family name of Miss Odessa Powell, Secretary of the Tennessee Geological Survey.

III. DESCRIPTION OF FOSSILS

Class GASTROPODA

Family MACLURITIDAE Woodward

Genus **Ceratopea** Ulrich

Genotype: *Ceratopea keithi* Ulrich

Ceratopea, Ulrich, Bul. Geol. Soc. Amer., vol. 22, p. 665, 1911.

Description. — Medium to large opercula, subcompressed-pyramidal to subconical, capuloid in outline; nuclear apex vertical or variously twisted, and usually situated toward the right side of the shell. Carinae extend from the nuclear apex to the opercular rim, dividing the shell into subtriangular to subquadrangular dorsal and ventral areas. Opercular rim situated at the base of the shell, varying in outline from subquadrangular, subelliptical to subcircular and in surface from plane to sinuous; often separated from the upper portion of the shell by a shallow, concentric sulcus. Opercular muscle cavity appears to have occupied the whole of the interior of the operculum but it is frequently almost filled by mineral deposition. No point of direct muscular attachment is shown. However, the entire interior of *C. calceoliformis* is cavernous and *C. capuliformis* exhibits a fine line encircling the muscle cavity just inside the opercular rim; it is possible that this marks the line of muscular attachment. Surface marked by fine concentric lines, bending with the sinuosity of the opercular rim.

Ceratopea keithi Ulrich

Plate XIII, Figs. 13-16.

Operculum of ? *Maclurea*, Bassler, Bul. Geol. Surv. Va., II-A, pl. 20, fig. 3, 1909.

Ceratopea keithi Ulrich, Bul. Geol. Soc. Amer., vol. 22, p. 665, 1911.

Ceratopea keithi Ulrich, Butts, Geol. Surv. Ala., Special Rep. No. 14, pl. 18, figs. 5-8, 1926.

Description. — Shell medium to large, breadth about one-half the height; subcompressed-pyramidal to subconical

in outline. Nuclear apex somewhat acuminate, varying from vertical to slightly tilted anteriorally, and in position from near the right margin to almost one-third the distance between the two lateral margins of the shell.

The outer surface is divided by carinae and gentle ridges into four subtriangular areas. A sharp carina extends from the apex to the posterior base of the opercular rim, separating the dorsal and ventral surfaces. A gentle ridge ventral to the above carina extends from the apex to the opercular rim at a point near the posterior end of the outer lip margin, defining a narrow subtriangular area which is about one-half as wide as the dorsal surface. The ventral surface proper, which is plano-convex, is bounded by the above gentle ridge posteriorly and anteriorly by another which extends from the apex to the opercular rim at the anterior end of the outer lip margin; this portion of the ventral surface is one-third less in width than the dorsal. A faintly developed ridge extends from the apex to the opercular rim at the posterior end of the inner lip margin; this, with the last named ridge, defines a subtriangular area between the inner lip margin and the apex, really a part of the dorsal surface which is gently convex.

Opercular rim subquadrangular to subelliptical, sinuous, concave and broader at the lip margins, inner and outer lip margins two to two and one-half millimeters in width, anterior and posterior opercular margins one to one and one-half millimeters wide.

Opercular muscle cavity varies from very shallow to one-fourth of the depth of the shell.

The surface is ornamented by numerous fine concentric lines which bend with the sinuosities of the opercular rim, present from the apex to the base, some few are slightly coarser than the others and are bounded by shallow sulci. A fairly deep sulcus separates the opercular rim from the upper part of the shell.

Occurrence. — Basal Cotter and upper Jefferson City formations, Springvale, Tennessee.

Plesiotypes. — No. 0-100, University of Illinois.

Ceratopea calceoliformis Oder n. sp.

Plate XIII, Figs. 5-7.

Description. — Operculum of medium size, subcompressed, capuloid in outline. Nuclear apex subtrigonal, compressed-convex dorsally, slightly concave ventrally, tilted to the right, located at three-fourths the distance from the left to the right lateral margin.

Dorso-ventral carina prominent, from the apex to the posterior base of the opercular rim. Dorsal surface subtriangular, gently convex, twice as wide as ventral. Ventral surface subrectangular, slightly concave anteriorly, somewhat convex posteriorly. Subapical region gently concave, with a faint ridge extending from the apex to the anterior opercular margin.

The opercular muscle cavity occupies the entire interior in some specimens, almost filled with silica in others; inner walls show impressions of concentric lines similar to the external surface.

Opercular rim subquadrangular, sinuous; inner opercular margin deeply concave, four millimeters wide; outer opercular margin very slightly concave, three millimeters wide; anterior opercular margin convex, two and one-half millimeters wide, posterior opercular margin plane, one and one-half millimeters wide.

Surface marked by fine concentric lines, more prominent on the lower half of the shell; every fifth line is a little coarser, and is bounded by a shallow sulcus; the number of the lines varies and in some specimens they show all the way from the base to the apex.

Occurrence. — Basal Cotter formation, along Mossy Creek, one and one-half miles southeast of Jefferson City, Tennessee.

Holotype. — No. 0-101, University of Illinois.

Ceratopea tennesseensis Oder n. sp.

Plate XIII, Figs. 4, 8, 12.

Description. — Operculum of medium size, subpyramidal, tilted capuloid in outline. Nuclear apex subtrigonal, compressed-convex dorsally and ventrally, tilted to a position almost even with the right lateral margin. The dorso-ventral carina almost bisects the shell, and extends from beneath the apex near the frontal base to the posterior base of the opercular rim; at the front it bends a little to the right basally, forming a faint subapical ridge and giving this area the appearance of the shorter face of a pyramid. Both dorsal and ventral surafces subtriangular, subequally convex, ventral four-fifths as wide as the dorsal.

Opercular muscle cavity open less than one-third of the length of the operculum. Opercular rim subquadrangular to subtriangular, sinuous, not well preserved, the width appears to have been nearly uniform, concave at the inner and outer margins.

Concentric lines on the surface very prominent basally, alternating irregularly between very fine and fairly coarse ones which form narrow concentric ridges bounded by shallow sulci.

In general appearance this species simulates *C. calceoliformis*, but is more nearly equal dorsally and ventrally, the dorso-ventral carina extends farther forward; the apex is blunter, less concave below, and is nearer the right lateral margin; and the body of the shell is thicker.

Occurrence. — Cotter formation, one mile southwest of Alpha, Tennessee.

Holotype. — No. 0-102, University of Illinois.

Ceratopea robusta Oder n. sp.

Plate XIII, Figs. 9-11.

Description. — Operculum thick, small to medium; larger specimens one-third higher than wide; subconical to subcompressed-conical in outline. Nuclear apex rounded to fairly sharp in unworn specimens, sharply twisted to a position on the dorsal surface about five millimeters below the top and even with the right lateral margin of the shell.

The dorso-ventral carina extends from the apex to the posterior base of the opercular rim. Dorsal surface highly convex, most convex along an ill-defined ridge which extends from the apical area to the anterior portion of the posterior opercular margin, one-fourth higher than the ventral surface, subequal in width; vental surface plano-concave.

Opercular muscle cavity open for one-eighth to one-fourth the length of the shell. Opercular rim subcircular; not well preserved, but appears to have been fairly regular, averaging about one and one-half millimeters in width.

Concentric lines on the surface nearly uniform in thickness and spacing, covering the shell from the apex to the base, best preserved toward the base.

Occurrence. — Upper Jefferson City and basal Cotter formations, Old Mossy Creek Mine, Jefferson City, Tennessee.

Cotypes. — No. 0-103, University of Illinois.

Ceratopea capuliformis Oder n. sp.

Plate XIV, Figs. 1, 5-6.

Description. — Operculum shallow, small to medium in size, width and height subequal; subcompressed-pyramidal, capuloid in outline. Nuclear apex well defined, somewhat rounded at the end, twisted dorso-laterally, situated along the right lateral margin about half way between the top and the base of the shell. The dorso-ventral carina extends from the apex to the posterior opercular margin; dorsal surface prominently convex, somewhat tilted-triangular, about twice as wide as the ventral surface; ventral surface plano-concave, sublenticular, steeply inclined from dorso-ventral carina to the opercular rim.

Opercular rim subcircular to sublenticular, apparently uniform in surface and width, width one to one and one-half millimeters; outer opercular margin occupies more than half of the circumference; inner opercular margin scarcely preseved but seems to have been slightly wider than the rest of the rim and gently depressed.

Opercular muscle cavity open for one-third to one-half the length of the shell; a fine line encircles the cavity between its

upper boundary with the opercular rim, this possibly marks the attachment of the muscle in the operculum.

Concentric lines on the surface nearly uniform in thickness and spacing, passing from right to left along the base of the dorsal surface and bending toward the apex at the dorso-ventral carina, more or less parallel to the carina on the ventral surface.

Occurrence. — Upper Jefferson City and basal Cotter formations, athletic field of Carson-Newman College, Jefferson City, Tennessee.

Holotype. — No. 0-104, University of Illinois.

Ceratopea cuneata Oder n. sp.

Plate XIII, Figs. 1-3.

Description. — Operculum of medium size, breadth about one-third less than the height; subcompressed-pyramidal, somewhat wedge-shaped in outline. Nuclear apex acuminate, vertical, located almost centrally between the lateral margins of the shell.

The outer surface is divided by two well-defined carinae into three subtriangular areas. The longest and sharpest carina passes from the anterior end of the inner opercular margin through the apex to the left angle of the posterior opercular margin, bounding the left margin of the subtriangular compressed-convex dorsal surface. The shorter carina extends from the apex ventrally to the posterior end of the inner opercular margin, and together with the first carina defines a narrow subtriangular area between the dorsal and ventral surfaces; this area is about one-half as wide as the dorsal surface. The ventral surface slopes at about forty-five degrees from the apex to the outer opercular margin, is a little less than half as high as the dorsal surface, and about four-fifths as wide. The anterior end between the ventral and dorsal surfaces is a narrow, subtriangular, very convex ridge extending from the apex to the anterior end of the inner opercular margin. The dorsal surface is subrectangular, compressed-convex. Opercular rim subquadrangular, sinuous, concave and about five millimeters wide along the inner and

outer opercular margins, smooth along the anterior and posterior opercular margins, and about two and one-half millimeters wide.

Opercular muscle cavity entirely open in one specimen, taking up the whole subconical inner space of the shell, in other specimens it is more or less completely filled with silica.

The surface markings are not well preserved, but are fine and regular; the opercular rim is set off from the upper portion of the shell by a deep sulcus which varies in position from two to three millimeters above the base and above which the fine concentric lines begin.

Occurrence. — 125 to 150 feet above the base of the Cotter formation, two-fifths of a mile northeast of the Lee Highway intersection with the Bloomingdale road at Kingsport, Tennessee.

Cotypes. — No. 0-105, University of Illinois.

Ceratopea compressa Oder n. sp.

Plate XIV, Fig. 14.

Description. — Operculum large, thin, breadth a little less than the height; compressed-subpyramidal to subquadrangular in outline. Nuclear apex broadly rounded, sublunar, vertical, situated even with the right lateral margin of the shell.

The dorso-ventral carina extends from the apex to the left end of the posterior opercular margin. Dorsal and ventral surfaces subquadrangular, about equally convex, subequal in width, ventral surface about two-thirds as high as the dorsal. Anterior subapical region slightly concave; less than one-third as wide as the dorsal surface.

Opercular rim subrectangular to subelliptical, sinuous, inner opercular margin concave, four millimeters in width, outer opercular margin not preserved. Opercular muscle cavity narrow; open for three-fourths of the length of the shell.

The surface shows only faint traces of concentric lines, except toward the opercular rim; a very narrow, shallow sulcus separates the opercular rim from the upper portion of

the shell. Above this sulcus there occurs a very slightly elevated band, about four millimeters in width, above which there is another narrow, shallow sulcus which encircles the dorsal surface.

Occurrence. — Cotter formation, at Lee Valley, eight and one-half miles northwest of Rogersville, Tennessee.

Holotype. — No. 0-106, University of Illinois.

Ceratopea corniformis Oder n. sp.

Plate XIV, Figs. 2-4.

Description. — Operculum small, width about one-half of the height; recurved, horn-shaped to tilted conical in outline. The nuclear apex is acuminate, occurs at the summit of the shell, directed upward, and tilted to the right so as to project slightly beyond the right lateral margin of the shell.

The outer surface is not divided by carinae, but takes the form of a recurved cone; dorsal surface distinctly convex, one-fifth broader and one-fourth higher than the ventral; ventral surface recurved-concave.

Opercular rim subcircular, non-sinuous, width one millimeter at the inner opercular margin, one-half millimeter elsewhere.

Opercular muscle cavity shallow, occupying less than one-fifth of the interior of the shell unless it has been filled with silica. The surface is marked by faint, poorly preserved concentric lines.

Occurrence. — Basal Cotter formation, Old Mossy Creek Mine, Jefferson City, Tennessee.

Holotype. — No. 0-107, University of Illinois.

Ceratopea sulcata Oder n. sp.

Plate XIV, Figs. 9-13.

Description. — Operculum large, elongate, breadth slightly more than one-half of the height; subcompressed-conical to subspatulate in outline. Nuclear apex vertical, sublunate, situated about even with the right lateral margin of the shell.

The dorso-ventral carina almost bisects the outer surface and passes from the upper boundary of the inner lip margin through the apex to the left end of the posterior opercular margin. Dorsal surface subspatulate, distinctly convex. Ventral surface sublunar, gently convex, and restricted basally by the opercular rim.

The opercular rim is subquadrangular, sinuous; inner and outer opercular margins concave, five millimeters wide; anterior opercular margin plano-convex, four millimeters wide; posterior opercular margin smooth, two millimeters wide; the opercular rim takes the form of an elevated collar owing to its great width and its being separated from the rest of the exterior by a well defined sulcus which completely encircles the shell; because the sulcus bends with the sinuosities of the rim, the width of this collar above the base varies from four to eight millimeters.

The opercular muscle cavity occupies less than one-sixth of the interior of the shell.

The only traces of concentric lines are above the collar, besides those on the collar.

Occurrence. — Upper Jefferson City formation, one and one-half miles southeast of Jefferson City and 125 feet below the top of the same formation along the Lee Highway one mile west of Church Hill, Tennessee.

Cotypes. — No. 0-108, University of Illinois.

Ceratopea subconica Oder n. sp.

Plate XIV, Figs. 15-17.

Description. — Operculum medium to large in size, breadth about one-half of the height; elongate, slightly twisted, semi-cylindrical to subconical in outline.

Nuclear apex not preserved, it seems to have been slightly rounded, nearly vertical but tilted to the right, and about even with the right lateral margin.

The dorso-ventral carina extends from the apex to the angle between the outer and the posterior opercular margins; dorsal and ventral surfaces sub-equal in width. A distinctive

feature of this species is the reversal of the usual convexity of the exterior; the ventral surface is highly convex while the dorsal is concave in its upper portion. This is caused by an anterior twisting of the whole apical region, producing a depressed area in the dorsal surface above the inner opercular margin; elsewhere the dorsal surface is convex but not so much so as the ventral. The ventral surface is less than one-fourth shorter than the dorsal. Another characteristic of this species is the narrow, elongate-conical form.

The opercular rim is subquadrangular in outline, surface not well preserved. The opercular muscle cavity occupies about one-sixth of the length of the shell but seems to be filled with silica.

The entire surface is marked by concentric lines; near the base some of these are coarser than the rest and are bounded by narrow, shallow furrows.

Occurrence. — Upper Jefferson City and basal Cotter formations, two miles west of Marble Hall, about eight miles southwest of Rogersville, Tennessee.

Holotype. — No. 0-109, University of Illinois.

Genus **Pondia** Oder nov.

Genotype: *Pondia powelli* Oder n. sp.

Description. — Thin, fairly flat, medium sized opercula; concavo-convex; capuloid, subovate to subalate in outline. Nuclear apex acuminate, subcentral, and gently inclined from the anterior toward the posterior portion of the shell. Carinae indistinct or wanting. Dorso-ventral areas poorly defined except in the apical region. The dorsal surface includes more than three-fourths of the shell; ventral surface subapically situated, narrow, less than one-fourth as wide as the dorsal. Opercular rim thin, produced into a simple margin with the subovate to subalate outline of the dorsal surface. Opercular muscle cavity occupies the entire shallow interior and conforms to the general shape of the shell. The surface is smooth except for very obscure concentric lines.

Pondia powelli Oder n. sp.

Plate XIV, Figs. 7-8.

Description. — Operculum of medium size, width and height subequal, thin, fairly flat; concavo-convex, capuloid, subovate to subalate in outline. Nuclear apex acuminate, subconical, gently inclined backward and slightly raised above the dorsal surface, subcentral in position.

The dorsal surface comprises more than three-fourths of the surface of the shell, convex-capuloid, subovate to subalate; the basal portions are deflected downward; the right side slants away from the apex in such a manner as to give the appearance of a wing.

The ventral surface is situated subapically and anteriorly, subtriangular in outline, slanting in all parts from the apex to the opercular rim, less than one-fourth as high as the dorsal surface.

The opercular rim is very thin, entire, and non-sinuous, making a simple suture. Opercular muscle cavity mostly filled with mineral matter, but it can be seen that it occupied the whole interior of the shell. It is possible that separate muscular processes from the foot fitted into this cavity.

The surface is smooth except for very obscure concentric lines; a gentle ridge encircles the dorsal surface at a point about four millimeters above its base; from this ridge the basal portions of the dorsal surface are deflected downward.

Occurrence. —Jonesboro limestone, Bristol, Tennessee.

Holotype. — No. C-100, University of Illinois.

University of Illinois.

PLATE XIII.

FIGS.

1–3. *Ceratopea cuneata* Oder n. sp.
Dorsal, carinal and ventral views of one of the cotypes. 125-150 feet above the base of the Cotter formation, two-fifths mile northeast of intersection of Lee Highway and the Bloomingdale road, Kingsport, Tennessee. (0-105, Univ. Ill.)

4, 8, 12. *Ceratopea tennesseensis* Oder n. sp.
Carinal, dorsal and ventral views of the holotype. Cotter formation, one mile southwest of Alpha, Tenn. (0-102, Univ. Ill.)

5–7. *Ceratopea calceoliformis* Oder n. sp.
Dorsal, ventral and carinal views of the holotype. Basal Cotter formation, Mossy Creek, one and one-half miles southeast of Jefferson City, Tenn. (0-101, Univ. Ill.)

9–11. *Ceratopea robusta* Oder n. sp.
Dorsal, ventral and carinal views of one of the cotypes. Upper Jefferson City—basal Cotter formations, Old Mossy Creek Mine, Jefferson City, Tenn. (0-103, Univ. Ill.)

13–16. *Ceratopea keithi* Ulrich.
Two dorsal, one carinal and one ventral view of two plesiotypes. Basal Cotter and upper Jefferson City formations, Springvale, Tenn. (0-100, Univ. Ill.)

(All figures natural size.)

PLATE XIII.

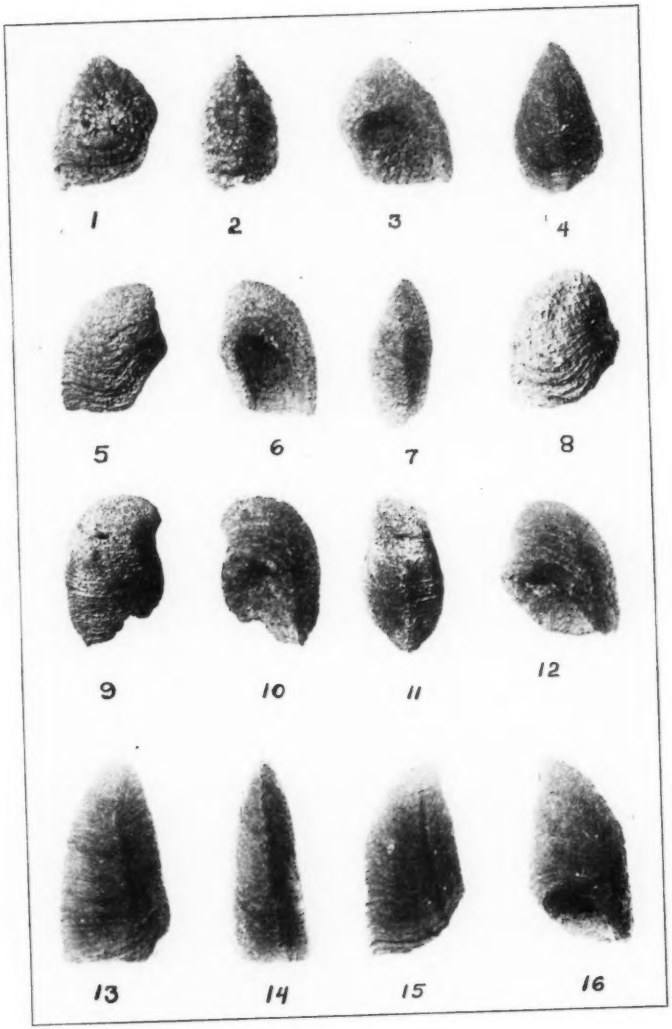


PLATE XIV.

FIGS.

1, 5–6. *Ceratopea capuliformis* Oder n. sp.
Dorsal, ventral and carinal views of the holotype. Upper Jefferson City—basal Cotter formations, athletic field of Carson-Newman College, Jefferson City, Tenn. (0-104, Univ. Ill.)

2–4. *Ceratopea corniformis* Oder n. sp.
Dorsal, ventral and lateral views of the holotype. Basal Cotter formation, Old Mossy Creek Mine, Jefferson City, Tenn. (0-107, Univ. Ill.)

7–8. *Pondia powelli* Oder n. sp.
Dorsal and ventral views of the holotype. Jonesboro Limestone, Bristol, Tenn. (C-100, Univ. Ill.)

9–13. *Ceratopea sulcata* Oder n. sp.

9, 13. Ventral and dorsal views of a badly worn specimen.

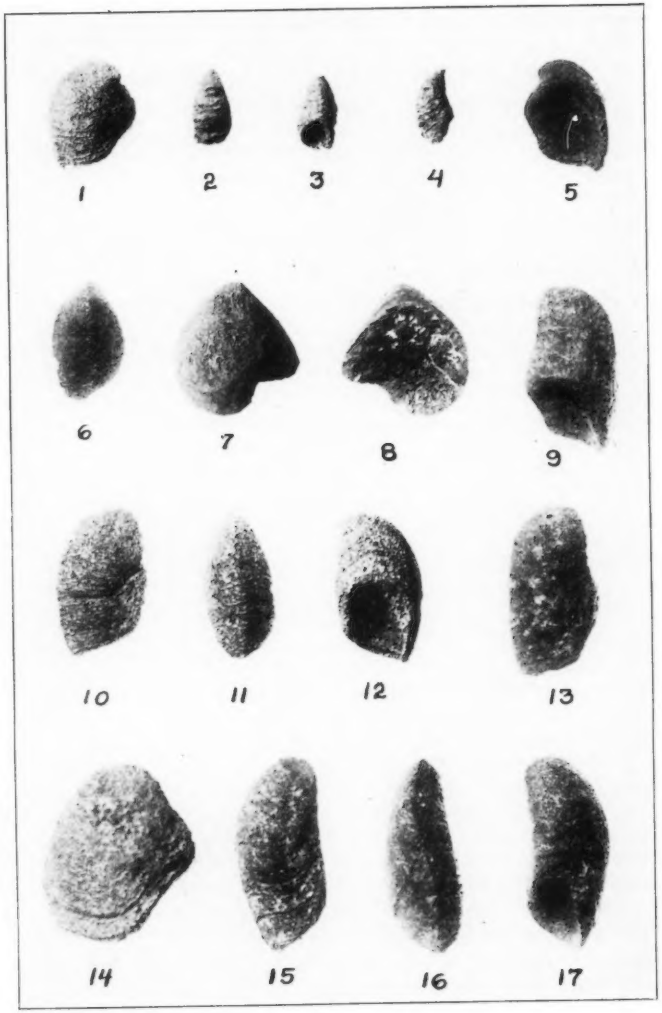
10–12. Dorsal, carinal and ventral views of a better specimen. Both cotypes: upper Jefferson City formation, one and one-half miles southeast of Jefferson City, Tenn.; and 125 feet below top of this formation on the Lee Highway, one mile west of Church Hill, Tenn. (0-108, Univ. Ill.)

14. *Ceratopea compressa* Oder n. sp.
Dorsal view of the holotype: Cotter formation in Lee Valley, eight and one-half miles northwest of Rogersville, Tenn. (0-106, Univ. Ill.)

15–17. *Ceratopea subconica* Oder n. sp.
Dorsal, carinal and ventral views of the holotype. Upper Jefferson City—basal Cotter formations, two miles west of Marble Hall, some eight miles southwest of Rogersville, Tenn. (0-109, Univ. Ill.)

(All figures natural size.)

PLATE XIV.



BOOK REVIEWS

A HISTORY OF FISHES, by J. R. Norman. New York, Frederick A. Stokes Company, 1931. xv + 462 pp. $7.50.

Since Dean's *Fishes Living and Fossil* went out of print, biologists and paleontologists have been at something of a loss for a volume which summarizes the anatomy and natural history of this group. This need assures the present volume of a ready welcome; and if Mr. Norman says less of fossils than his title indicates, he atones by his admirable digests of the essential biology of the class Pisces.

A History of Fishes belongs to that class of writing which the English refer to as "popular science"—but it is far removed from the slipshod, sensational work that the American public has come to associate with that term. In the twenty-one chapters into which his book is divided, Mr. Norman (who is an assistant keeper in the British Museum) treats such subjects as fish form and locomotion, respiratory organs, fins, sense organs, coloration and distribution and migration. Although not exhaustive, each chapter is adequate and dignified; and the brief list of books is sufficient to the need of the reader who has no professional zoologic interest in fishes. The one who has will already possess more extended bibliographies; yet the chances are that he will rely upon Norman for convenient summaries, cast in terms of the relationship of organs and structures to functions.

To the paleontologist, the chapter entitled "Fossils and Pedigrees" is specially interesting. Amounting to but twenty-three pages, it does not replace the work of Dean: nor does the classification adopted wholly agree with that familiar in paleontology. Thus the familiar class, Ostracodermi, is divided: the Anaspida, Cephalaspida and Heterostraci remain among the marsipobranchs, while the Antiarcha unite with the Arthrodira to form the class Placoderma. This, of course, implies that the appendages of such forms as *Pterichthys* and *Bothriolepis* are true paired limbs, rather than structures derived from the paired lappets of cephalaspid ostracoderms. Indeed, it is Mr. Norman's opinion that the placoderms are "an independent offshoot from the main stem of primitive sharks." One wishes that space had permitted amplification of this brief statement, whose supporting evidence lies in recent research not readily available to many who will use this book.

It would be unfair, however, to stress taxonomy, since Mr. Norman's book is built upon another viewpoint. One its essential objects are granted, it appears as a needed and well balanced volume.—Carroll Lane Fenton.

ANIMAL ECOLOGY, WITH ESPECIAL REFERENCE TO INSECTS, by Royal N. Chapman. New York, McGraw-Hill Book Company, 1931. x + 464 pp. $4.

Some years ago, when McGraw-Hill published a book of this title by Professor A. S. Pearse, one reviewer complained that they had offered a volume which neglected the modern quantitative and analytic aspects of ecology for older, descriptive ones. If that was true, Chapman's *Animal Ecology* is ample atonement, since in it description is reduced to a minimum.

Yet Chapman is not averse to old methods and concepts. In spite of Shelford's protest, he retains Schröter's term autecology, the ecology of the individual, or the individual group: the chapter on the "Biotic Factors in Autecology," indeed, is among the most stimulating in the volume. The several factors which Chapman groups under the headings of biotic, reproductive and survival potentials are among the most fundamental of organic existence, determining both the associations with which synecology may deal, and the duration of organic groups upon earth.

Chapters on light and temperature, and combinations of the two, emphasize their importance both as conditioning factors and as determinative ones—the latter, a role in which they bulk large throughout neo-Buffonian speculation. The chapter on "Physical Conditions of Environmental Media" aids in analyzing present environments, and in understanding the significance of those long environmental sequences or rhythms that mark geological history. In view of the difficulty that the geologist or paleontologist encounters when he attempts to apply the type of "modern" ecology that Pearse's critic seemed to desire, the utility of Chapman's summary comes as something of a surprise. Less can be gained in the historical field from his discussions of aquatic synecology—largely, it seems, because emphasis on insects requires that chief attention be given to the environments and communities of fresh waters. Although records of these are not lacking, they do not bulk large in the earth's strata.

The proper answer to this criticism, of course, is that Chapman has written an ecologic text book whose plan neither requires nor permits an inquiry into the ecology of past ages. That they have been mentioned is due to the reviewer's interest: in the absence of any treatise on paleoecology, the paleontologist must glean what he can from the writings of ecologic biologists. That the gleanings are large is emphasis upon the permanency of ecologic factors and principles.

Within its own proper field, Chapman's text leaves few gaps, and they largely are filled by long, and not too condensed bibliographies at the end of each chapter. In them the user who is not first an ecologist will find a convenient and modern index to literature which no text book can adequately summarize.—Carroll Lane Fenton.

SNAKES OF THE WORLD, by Raymond L. Ditmars. New York, The Macmillan Company, 1931. xi + 205 pp., 84 plates. $6.

Dr. Ditmars for years has been our chief interpreter of the ways and merits of serpents, against whom the occidental world cherishes a deep, but not wholly merited aversion. That aversion, and a rather morbid curiosity attendant upon it, seem to be the factors that account for the production of this beautifully illustrated volume. For its preparation "has been largely guided by queries about snakes,"—and those queries evidently dwelt largely upon those species that were large and powerful, or notoriously venomous.

Yet such guidance has not marred the book. There are excellent chapters on "The Serpent's World," on general habits, and on classification and distribution. The giant serpents of the tropics receive another chapter, and one each is devoted to harmless snakes of the New and Old Worlds. Poisonous snakes are grouped according to the areas which they inhabit—a device that should be welcomed by those who expect to travel in areas which possess venomous serpents. The reviewer, at least, has found it worth while to consult Chapter X ("Poisonous Snakes of North America") in planning his coming field season.

The most striking feature of the volume, however, is the eighty-four photographic plates. A snake may possess an irritable temper and deadly venom, yet be one of nature's finest subjects for the camera: witness the king cobra of Plate 38. Thus photographs which will serve for identification also possess value as art, and so add to the merits of an already excellent volume.—C. L. F.

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NOTE

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